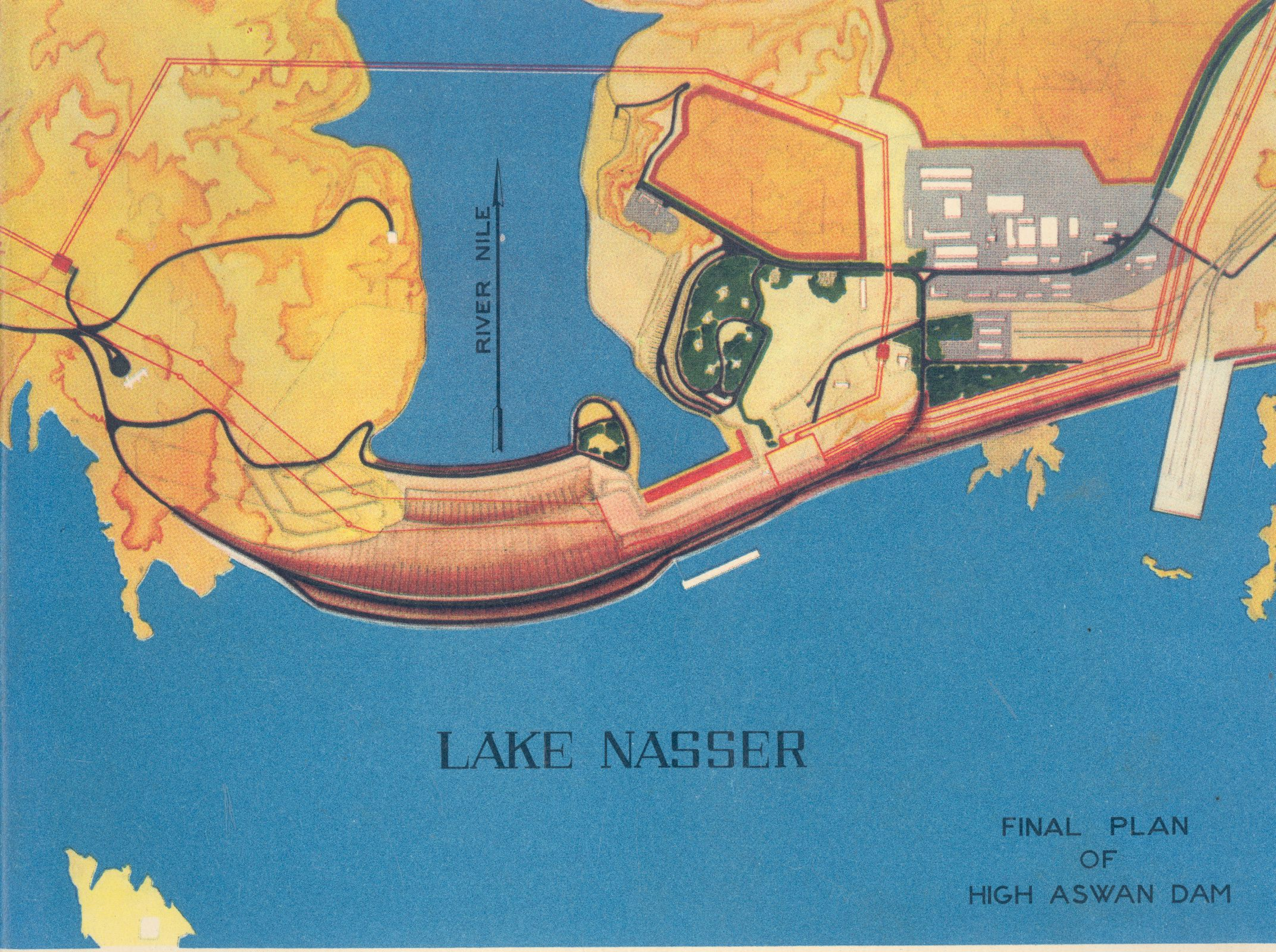



ASWAN HIGH DAM
AUTHORITY
ASWAN

# ASWAN HIGH DAM

MAY 1964

*This Dam has become the symbol of the will and determination of the people to fashion its life. It is also a symbol of its will to provide the right of land ownership for large multitudes of farmers, for whom this opportunity was never provided, throughout centuries of continuous feudal rule.*

**THE CHARTER**

SADD EL AALI AUTHORITY

# ASWAN HIGH DAM

## DIVERSION OF NILE

MAY 1964

## CONTENTS

PRESIDENT GAMAL ABDEL NASSER

# THE ASWAN HIGH DAM

## *NECESSITY OF THE DAM*

In the U.A.R. water is the dominating factor for agricultural development and the River Nile is the only source of water for the country.

The Nile discharge has an average of 84 billion cubic meters per year which can cover the present irrigation water requirements of both the U.A.R. and the Sudan, amounting to 52 billion cubic meters per year. But this discharge varies considerably from year to year and it can be as low as 45 billion cubic meters in one year, thus exposing the U.A.R. to disastrous droughts and can be as high as 150 billion cubic meters in another year, causing dangerous floods. For this reason, regulation of the Nile flow has always been a major problem for Egypt since the ancient history. A number of dams and barrages have been built on the Nile for its training and control. In spite of that, a big quantity of the Nile water amounting to an average of 32 billion cubic meters annually, flows to the Mediterranean, while it is badly needed for the reclamation of new areas to meet the requirements of the continuously increasing population.

Hence arose the idea of building a big dam across the Nile to store its water, saving the excess from high flood years to be used in the years of the low floods. This will guarantee the annual average of 84 billion cubic meters needed for the future expansion. The idea materialised in the project of the Aswan High Dam (Sadd-El-Aali).

## *DEVELOPMENT OF THE IDEA*

On 8th October, 1952, the National Revolution Council decided that investigations for the construction of a high dam should be started.

An International Committee was formed from a number of world famous leading professors and experts with wide experience in dam design and construction. This Committee was assigned to make a thorough study of the project and check its technical feasibility. On December 4, 1954, the International Committee reported supporting the project and emphasizing its soundness from every aspect.

Hence the Government decided to proceed immediately with its construction.

## *AGREEMENT WITH THE SUDAN*

According to the Water Treaties in effect between the U.A.R. and the Sudanese Republic, it was necessary to reach an agreement between the two countries on the utilization of the surplus water of the Nile before starting the execution of the project.

In 1959, an agreement was concluded which stipulates that:

a) The net live storage of the Aswan High Dam is calculated on the basis of the average Nile annual discharge at Aswan. After ensuring the prior water rights of both countries amounting to 48 billion cu.m. to the U.A.R. and 4 billion cu.m. to the Sudan, the net benefit of 22 billion cu.m. resulting from the High Dam is to be divided between both countries at the proportion of 7.5 billion cu.m. for the U.A.R. and 14.5 billion cu.m. for the Sudanese Republic.

b) The U.A.R. Government pays 15 million Sterlings to the Sudanese Government as an indemnity for the properties which will be inundated by the storage water within the Sudanese Boundaries, and the Sudanese Government takes the necessary measures for transferring the inhabitants of that region before the end of July 1963. (The U.A.R. has already paid the amount).

## *FINANCING OF THE PROJECT*

The estimated costs of the project amounted to 415 million pounds, about 35% of which had to be in foreign currency for the import of construction and power equipment.

As the country was engaged in an ambitious scheme for its development, the International Bank for Development has been approached for financing the foreign currencies required for the project. The Bank approved the financing after a thorough study of its technical and economic aspects by the Bank's Experts who were convinced with its soundness and importance to the country's development. On July 19, 1956, the Bank suddenly withdrew its approval. On the 26th July 1956, President Gamal Abdel Nasser declared the nationalization of the Suez Canal Company. The tripartite aggression took place on October 29, 1956.

The well known story of financing the High Dam ended with an agreement between the U.A.R. and the Soviet Union on 27th December, 1958, according to which the latter renders the former a long term loan of 34.8 million pounds to be used for the supply of equipment and technical assistance required for the execution of the First Stage of the project. This loan is to be paid on 12 annual instalments starting from 1964 at a reduced annual interest of 2.5%.

Furthermore, another agreement was signed between the two countries on July 27, 1960 for an additional loan of 78.4 million pounds for the completion of the whole project and to be paid on 12 annual instalments as from 1970.

*ECONOMIC RESULTS OF THE PROJECT*

The High Aswan Dam is considered to be the backbone of the national economic plan for the years 1961-1970. The benefits gained will be:

1) Expanding the cultivated area by 1.3 million feddans to be newly reclaimed (one feddan = 4,200 $m^2$).

2) Conversion of 700,000 feddans from the basin irrigation system to the perennial irrigation system thus multiplying their crop area.

3) Ensuring the water requirements for irrigation of the present and newly reclaimed lands.

4) Protecting the country against high floods.

5) Increasing the productivity of land by improving its drainage through lowering the ground water table.

6) Expansion in the rice crop for exportation.

7) Improving the navigation conditions along the Nile.

8) Generating an annual electric energy amounting to 10 billion K.W.H., to be used for industrial and agricultural development. Besides, it will increase the amount of energy produced from the present Aswan Dam Power Station.

The direct annual increase in the national income of the U.A.R. due to the construction of the High Dam is estimated at 234 million pounds.

For the Sudan, the High Dam will avail an extra quantity of irrigation water amounting to 14.5 billion cu.m. annually. This extra water will be used for agricultural expansion by three fold the present cultivated area.

## BRIEF DESCRIPTION OF THE PROJECT

The project comprises the construction of a rockfill dam across the Nile, 7 kms south of the present Aswan Dam. The Dam will have a total length of 3,600 m of which 520 m are through the present channel. It will be 111 m high above the Nile bed, 980 m wide at its bottom and 40 m wide at its top. Its body is composed of rockfill, sand and clay. It has an impervious core, a grout curtain extending 180 m under the core to meet the bed rock, and a horizontal upstream impervious blanket. This design was chosen as the best to suit the requirements for its safety, its dynamic stability as well as the economical use of the building materials in the vicinity.

Water will be diverted to flow through a new water passage, 1950 m long composed of two open canals interconnected with six main tunnels driven through the virgin rock under the right wing of the dam. The tunnels are equipped with control and service gates. Each tunnel has two outlet branches feading 12 turbines, each having a capacity of 175,000.kw.

The artificial lake formed by the dam will be one of the largest in the world, having a length of 500 kms and an average width of 10 kms.

There will be a spillway in the left wing of the dam to overflow the water which exceeds the maximum allowable level of storage.

The total reservoir capacity will be 157 billion cu.m. of which 30 billion cu.m. are allowed for the accumulation of silt over some 500 years, 37 billion cu.m. for protection against high floods, 10 billion cu.m. to account for seepage and evaporation losses. The rest of the capacity will be enough for the live storage necessary to ensure an annual net supply of 74 billion cu.m. for the UAR and the Sudan.

The Dam is constructed according to the following stages:

1) The First Stage comprises the construction of the new diversion channel and the body of the dam to the height of 47.5 m above the Nile bed. It was scheduled to close the Nile and divert its flow through the new passage on the 15th of May, 1964. The required height of the dam will be reached next November and will enable the storage of 9.5 billion cu.m. of water in 1964 i.e. 4 billion cu.m. in addition to the storage capacity of the present Aswan Dam.

2) The construction of the dam will proceed gradually and the additional storage capacity will increase to 6 billion cu.m. in the year 1965 and to 8 billion in the year 1966. In 1967 it will be possible to store the flood water completely, if the flood will not exceed its mean value. The dam construction will be completely finished by 1968.

3) Three power units will be ready for operation by the end of 1967 together with one line of the two 500 kv high voltage transmission lines to Cairo. The whole transmission and distribution system will be completed by the end of 1968. The number of operating units will increase gradually at the rate of 3 units per year until the final completion of the power station in 1970.

## VOLUMES OF MAIN WORKS

The volumes of the main works encountered in the construction of the High Dam until its completion are:

1) *Diversion Channel*

| | | |
|---|---|---|
| Rock excavation | 9,704,000 | cu.m. |
| Soft soil excavation | 1,233,000 | " |
| Total excavation | 10,937,000 | " |

2) *Tunnels and Tunnel Intakes*

| | | |
|---|---|---|
| Rock excavation | 650,000 | " |
| Concrete for tunnel lining | 365,000 | " |
| Concrete for intakes | 160,000 | " |
| Gates and mechanisms | 10,500 | tons |

3) *The Dam*

| | | |
|---|---|---|
| Rock, muck and sorted rocks | 21,500,000 | cu.m. |
| Sand | 15,220,000 | " |
| Clay for impervious core and horizontal blanket | 3,035,000 | " |
| Filters | 630,000 | " |
| Injection of vertical curtain | 350,000 | l.m. |
| Concrete for galleries | 140,000 | cu.m. |
| Rock excavation | 690,000 | " |
| Rock pitching | 185,000 | " |

4) *Spillway*

| | | |
|---|---|---|
| Rock excavation | 980,000 | cu.m. |
| Soft soil | 400,000 | " |
| Concrete | 26,000 | " |

5) *Power Station*

| | | |
|---|---|---|
| Concrete for power house | 495,000 | " |
| Gates and mechanisms | 19,700 | tons |
| Generating units | 28,500 | " |
| Transformers and Switchgear | 12,000 | " |

6) *Transmission System*

| | | |
|---|---|---|
| Excavation | 1,430,000 | cu.m. |
| Concrete | 116,000 | " |
| Buildings | 12,000 | " |
| Metallic construction | 67,000 | tons |
| Conductors | 35,000 | " |
| Isolators | 690,000 | units |
| Transformers and Switchgear | 20,000 | tons |

## *CHARACTERISTICS OF THE HIGH DAM*

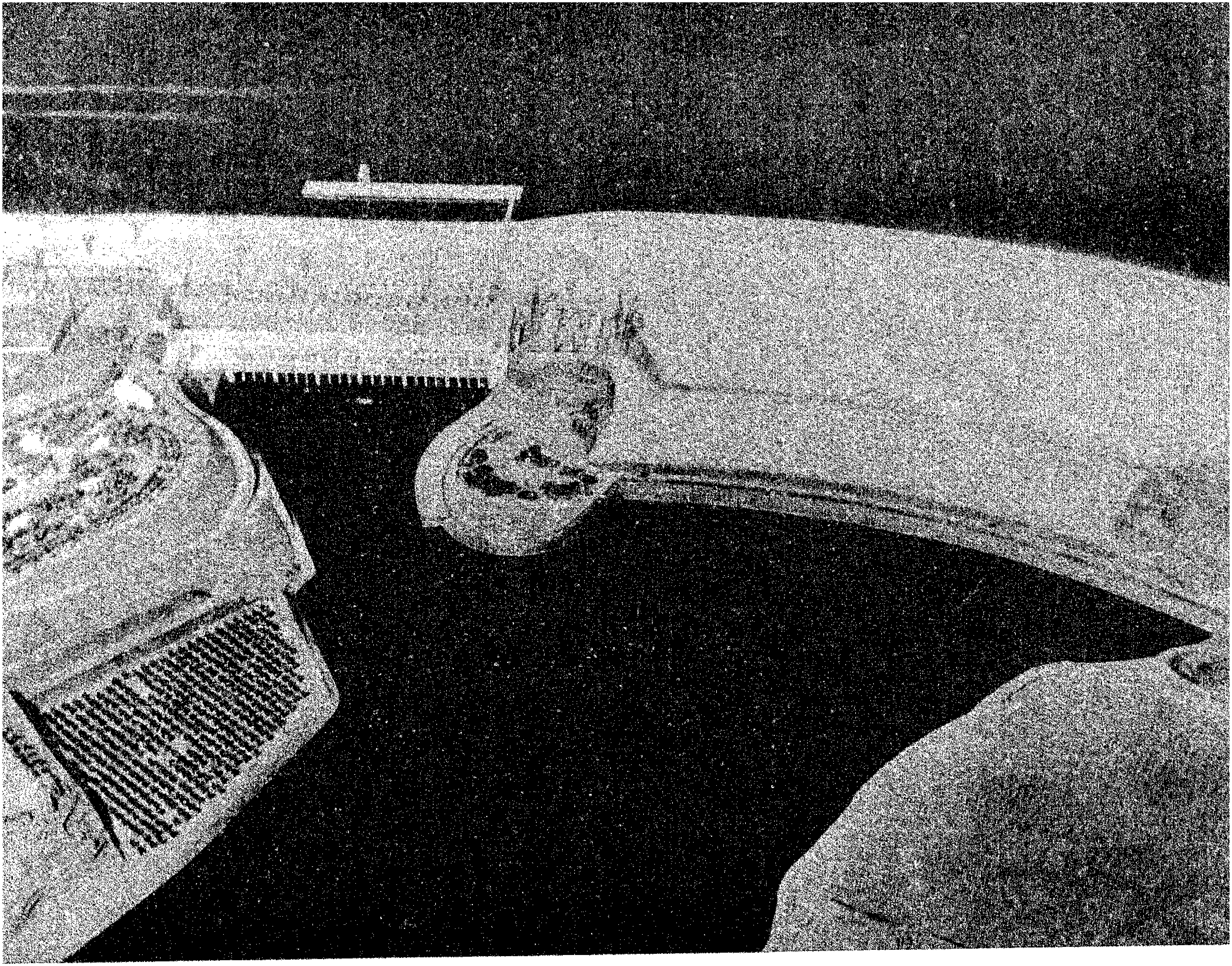
The High Dam is characterized with certain features, the most important of which are:

1) It will be the largest rockfill dam ever constructed in the world up till now.
2) The vertical antifiltration curtain which will be injected through the alluvial materials under its core, to the depth of 180 m till it reaches the bed rock, will be the largest of its kind in the world.
3) The High Dam is being constructed in the storage lake of the present Aswan Dam i.e. in a water body 35 m deep. Besides, the construction programmes have to be scheduled as to meet the present irrigation requirements in full.

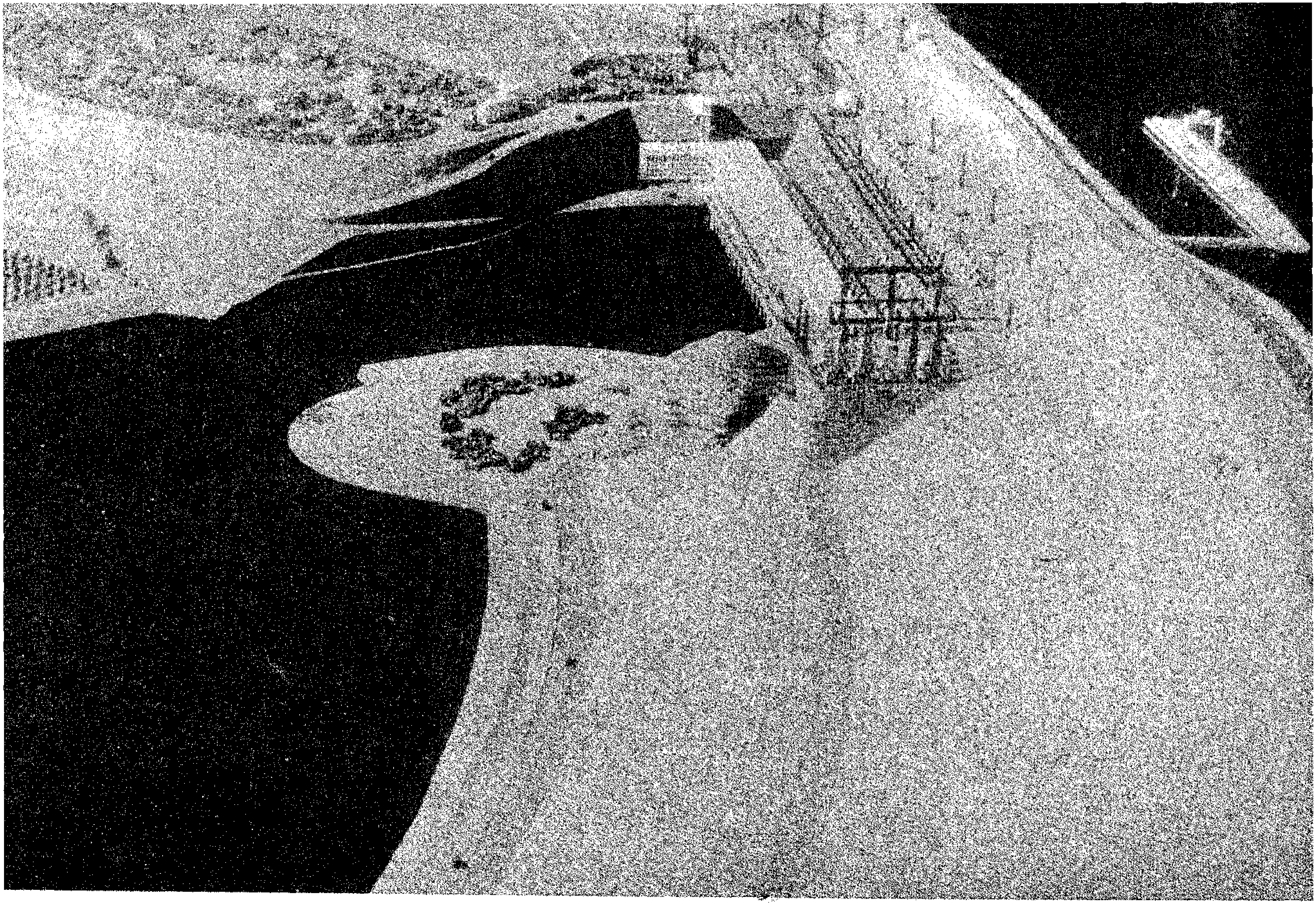
## EXECUTION OF THE PROJECT

The execution of the project was inaugurated on the 9th of January, 1960, when President Gamal Abdel Nasser blasted the first charge of explosives for the excavation of the diversion canal. Inspite of the difficulties encountered during the execution, and the extra volumes of works added especially in the items of excavation and concreting, due to more difficult natural conditions than anticipated, it was possible to finish the first stage of the project in time and the Nile will be diverted to its new passage on the 14th of May, 1964, as scheduled. A brief account of the works completed in the first stage will follow.

Plan of the Construction Site



General view of the project



General view of the project

## EXCAVATION OF DIVERSION CANALS

The new diversion passage is composed of an Upstream Canal leading the water from upsteam the dam, through the tunnels, to the Downstream Canal and back to the Nile downstream the dam.

The excavation of the two canals was mainly in the rock and was as deep as 85 m in some locations. It was done by drilling bore holes using all kinds of percussion and rotary boring machines operated electrically and pneumatically. The holes were eharged with explosives, then blasted and the resulting rocks were excavated by electric shovels 4 cu. m. capacity and 25 t dumpers.

The inlet of the Upsteam Canal and the exit of the Downstream Canal, originally submerged under water, were excavated to the designed profile by floating suction dredgers.

The excavation of the canal necessitated the installation of wide networks of water, compressed air and power all over the site.

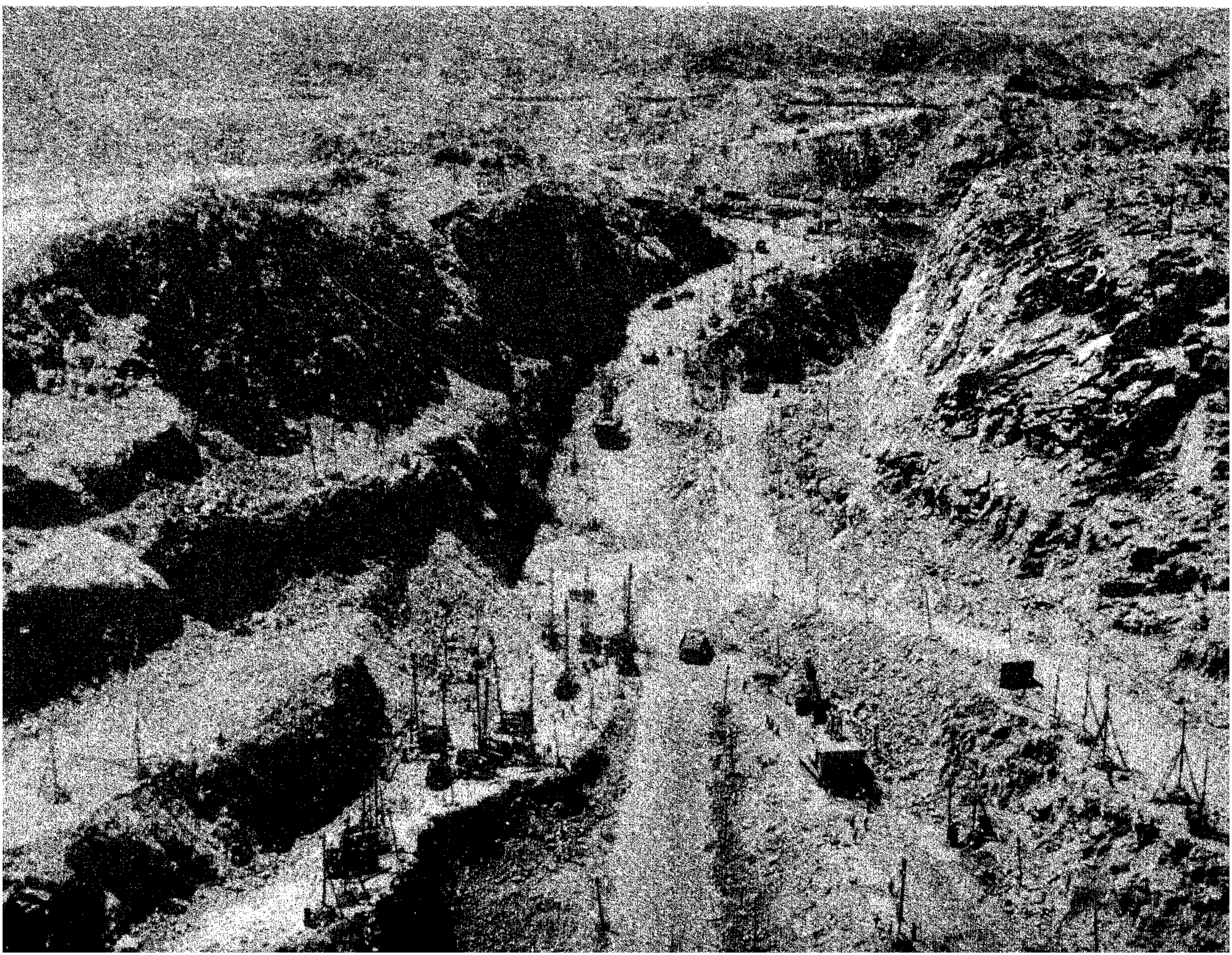
The excavation process continued 24 hrs per day all the year around, inspite of the summer heat which sometimes reaches over 50°C in the shade.

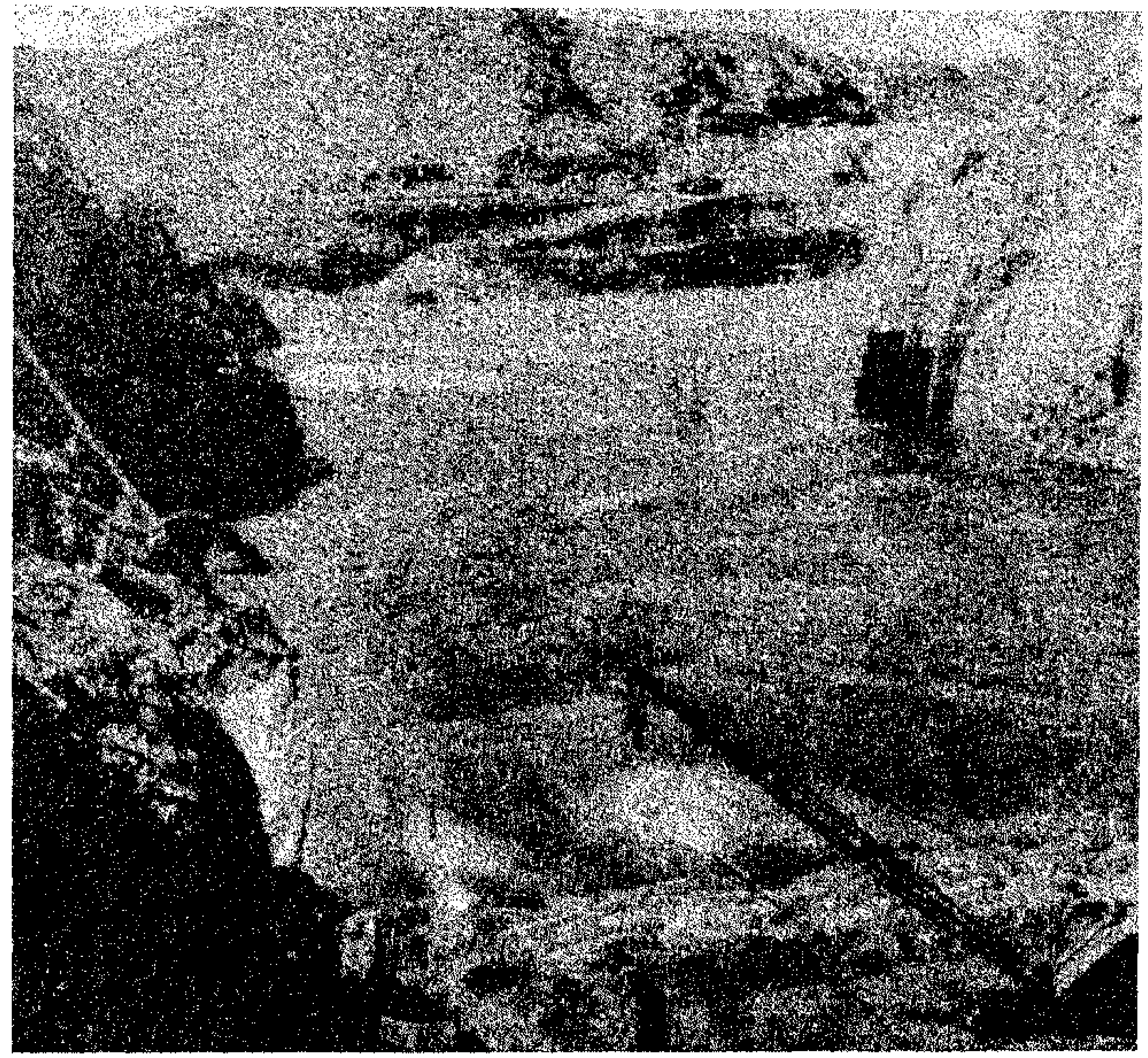
The total volume of canal excavation in the first stage was 10,687,000 cu.m. of which 9,454,000 cu.m. were in granite and 1,233,000 cu.m. in soft soils. 3,700 tons of explosives were used in blasting the rocks. The daily rate of excavation reached a maximum of 23,000 cu.m. on 18th July, 1963.

The excavation of both open canals was completed under the protection of a temporary sand cofferdam at the inlet and a rock plug at the end of the downstream canal.

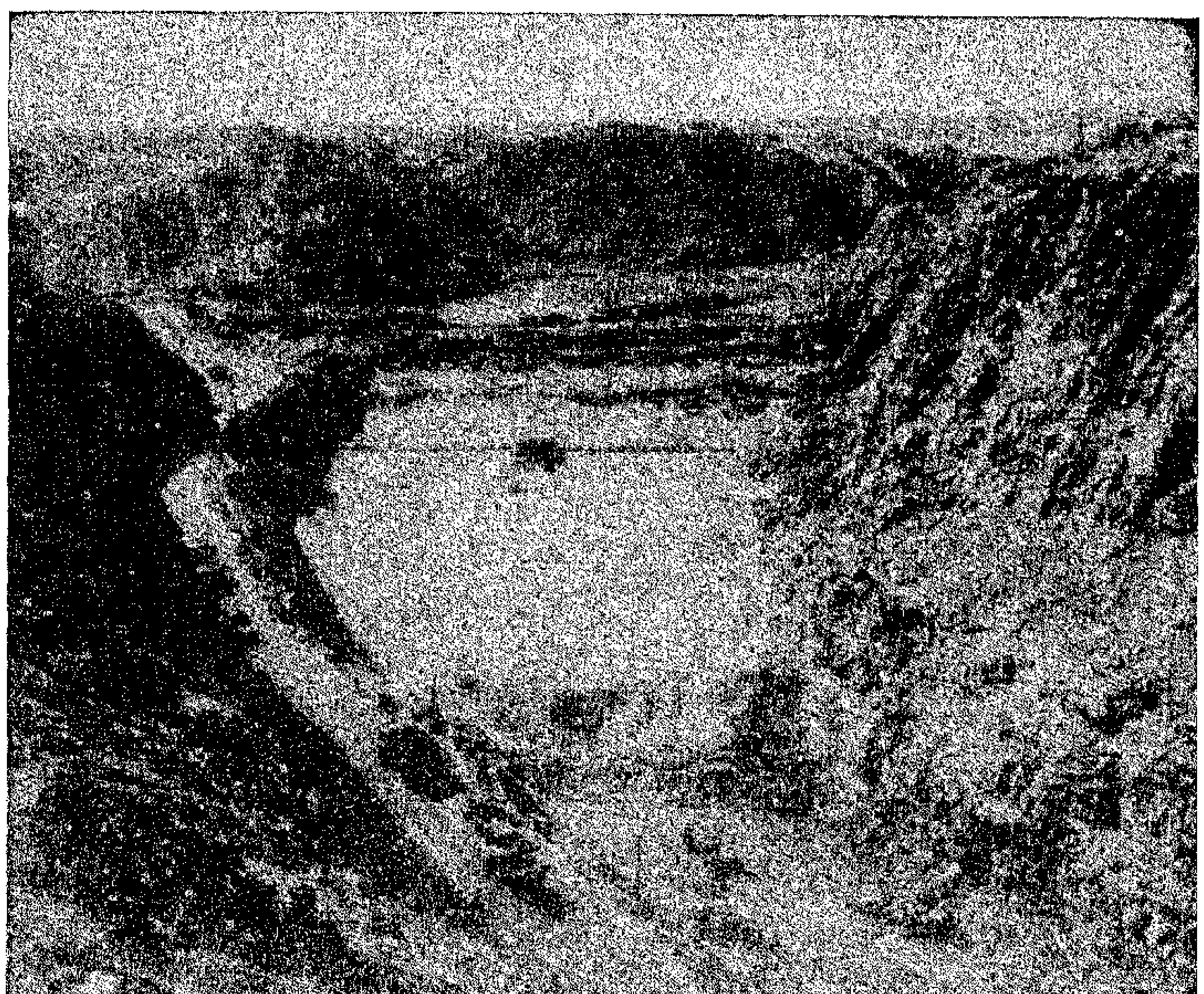
Before flooding the canal, it was necessary to remove both the cofferdams and the plug in order to complete the canals to the required profile. The only chance to accomplish this was during the summer of 1963, when the level of the reservoir of the Aswan Dam is low. This necessitated the construction of two temporary cofferdams during the period July-September, 1963 with a total volume of sand amounting to 875,000 cu.m. These temporary cofferdams were built according to the latest dam construction, vibrated, equipped with filters, drainage well points, etc. They will be removed at and after the diversion date.

Upstream canal in June 1963



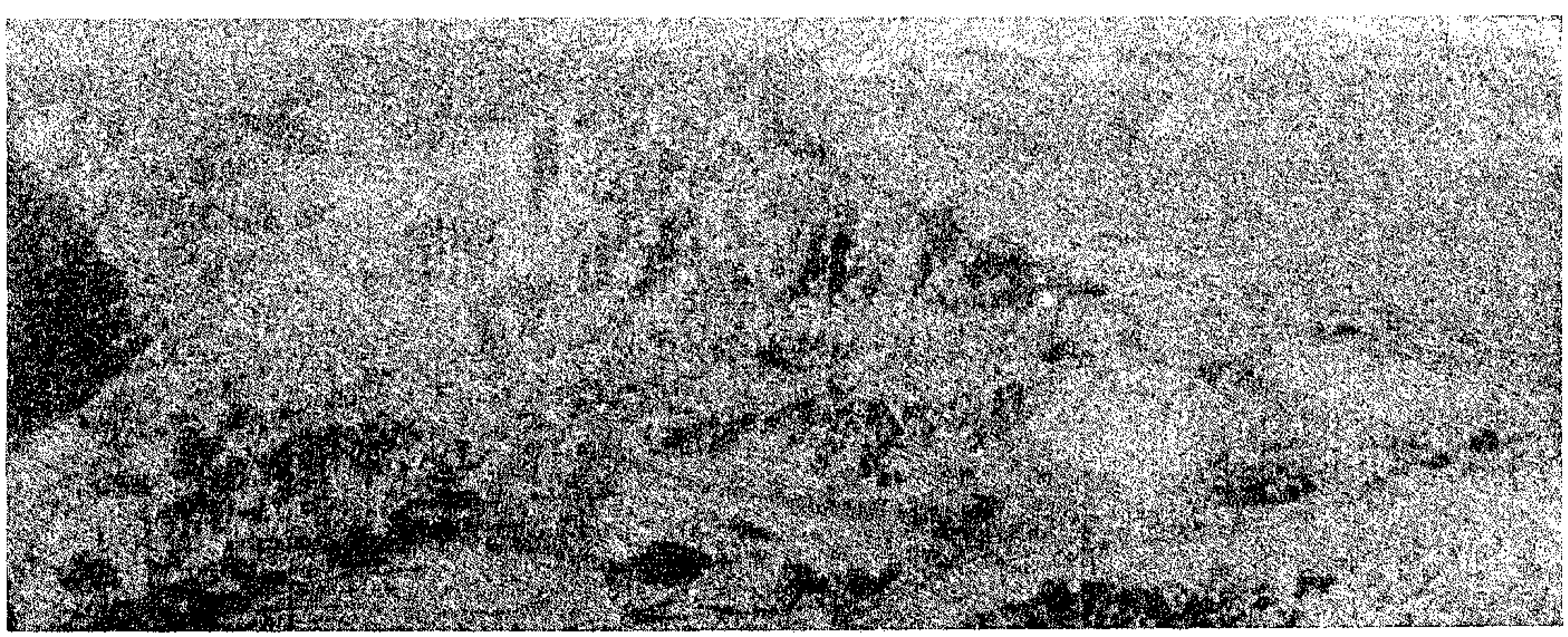


Filling of 2nd U.S. Temporary Sand Cofferdam by Hydromechanisation.



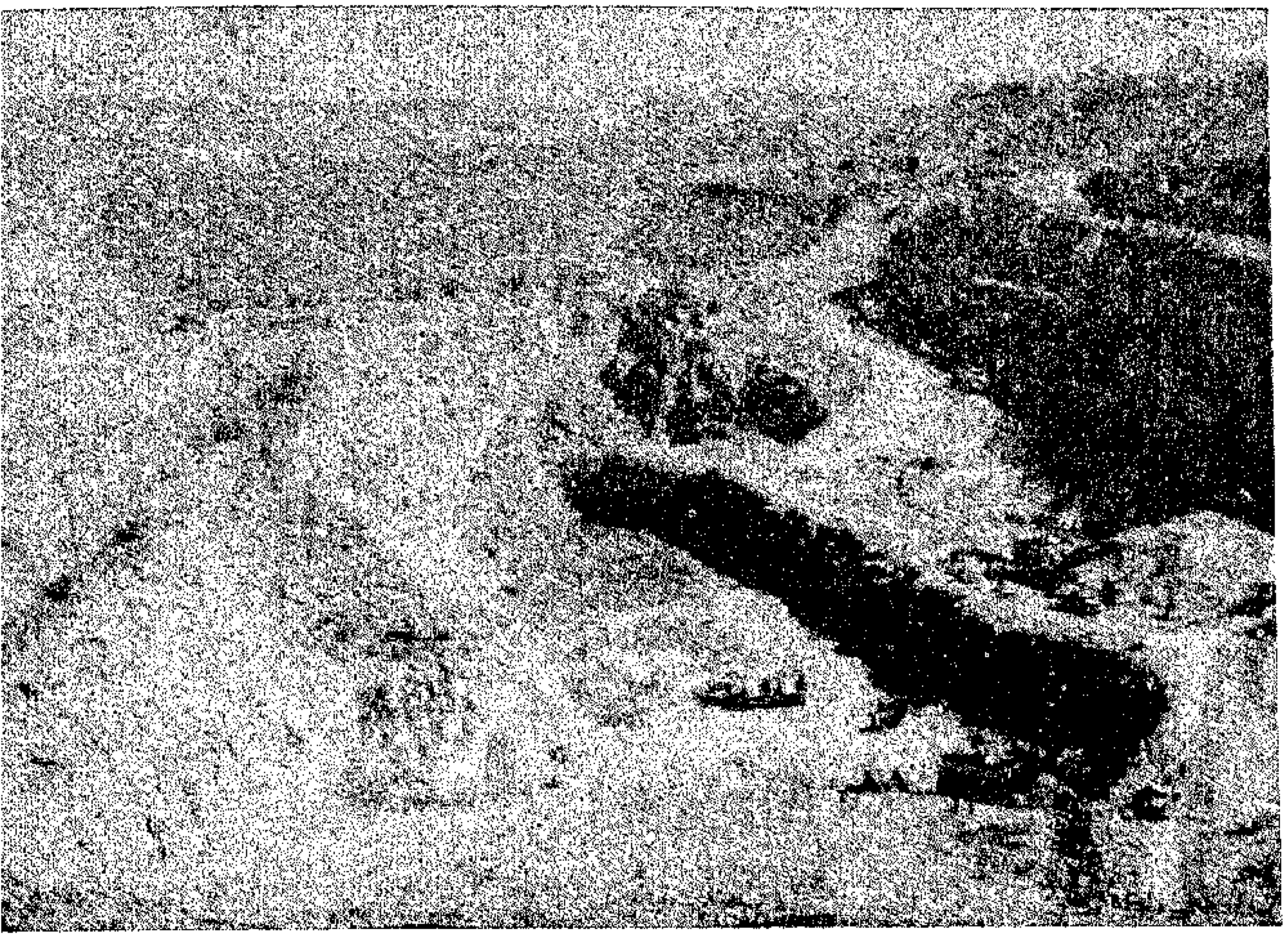
2nd U.S. Temporary Cofferdam after completion.

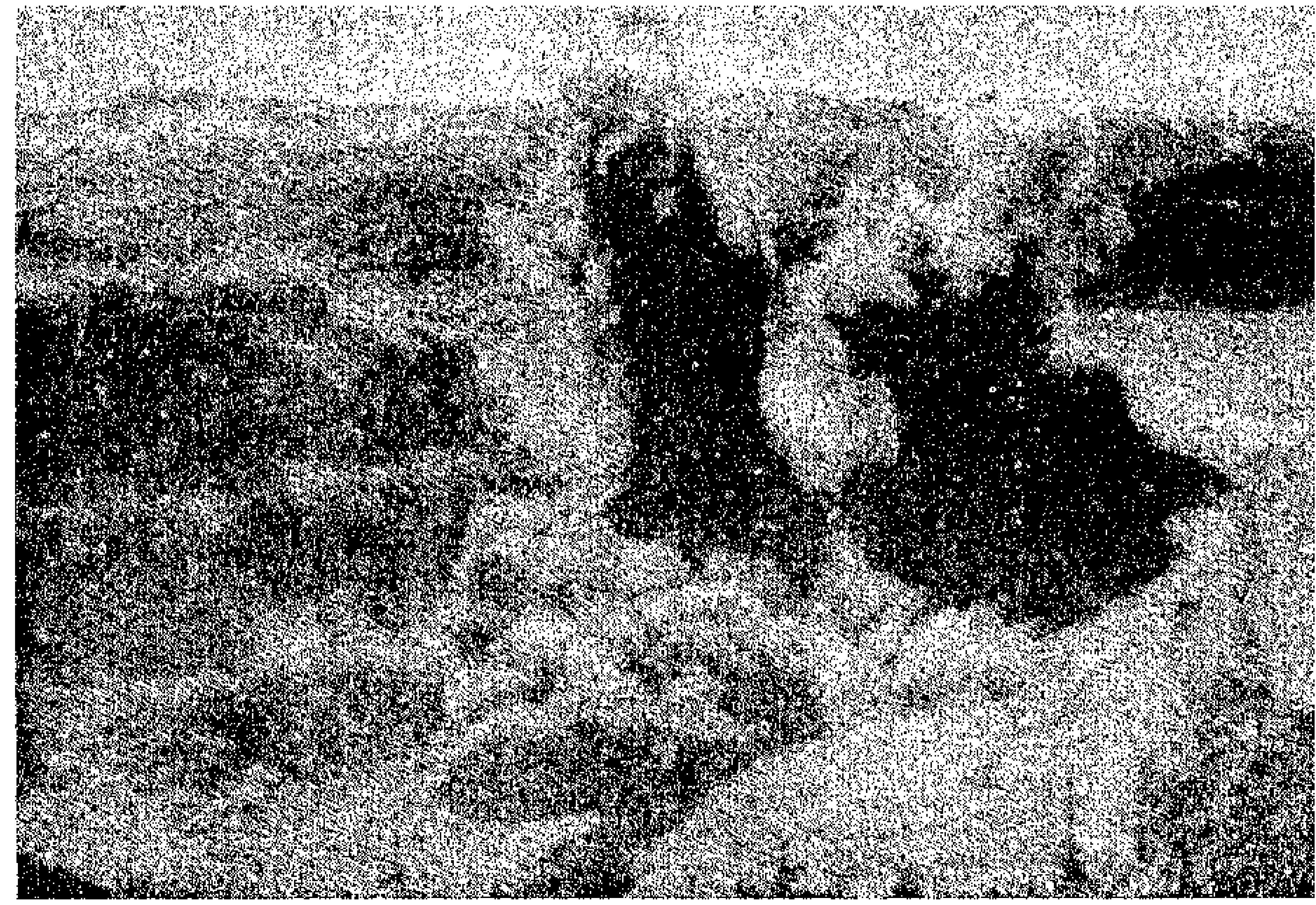
Excavation at different levels in the Downstream Canal



Downstream Canal in November 1962

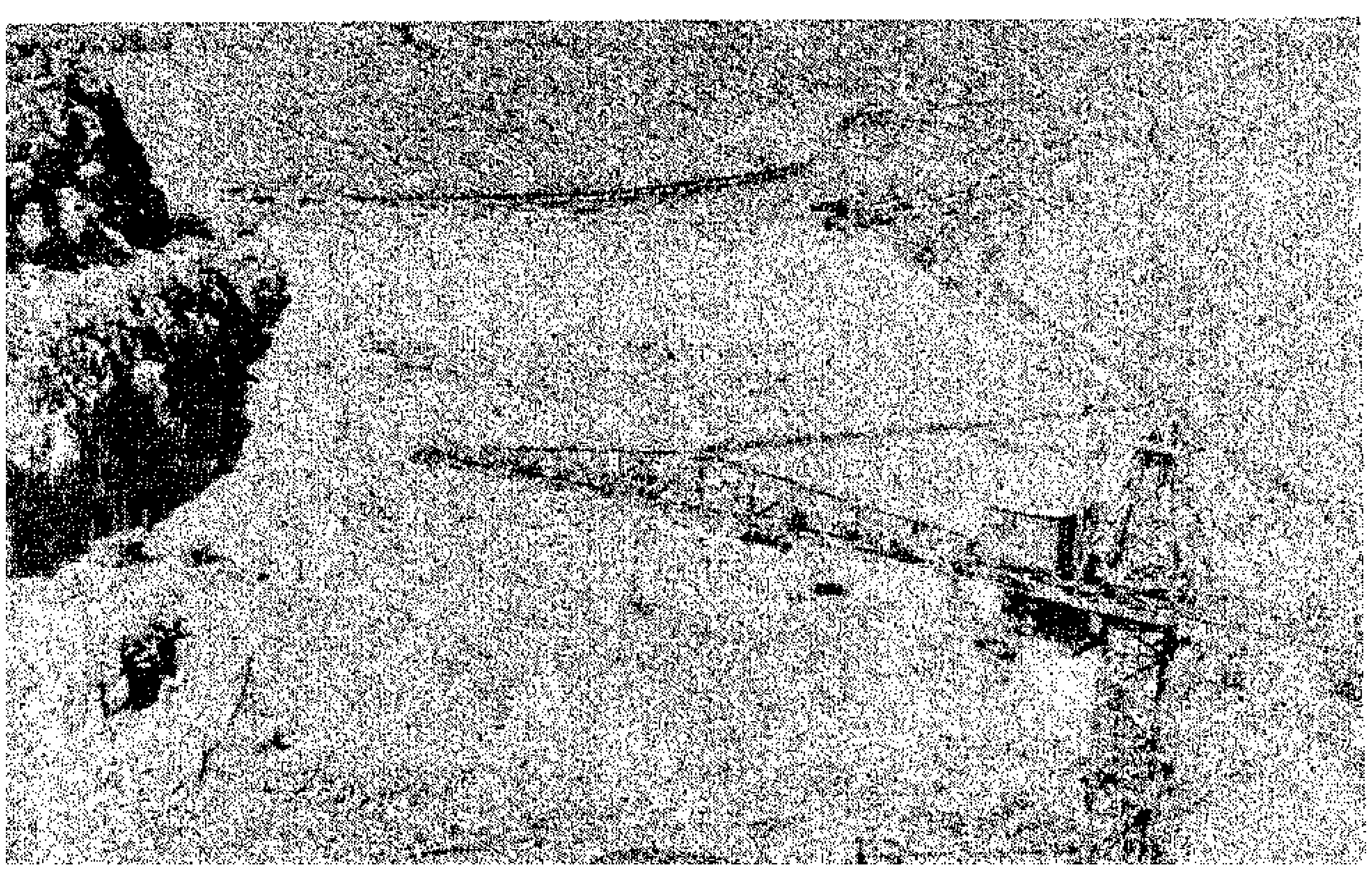
Rock excavation in D.S. Temporary Sand Cofferdam Site. Drilling machines during operation seen on the virgin rock plug.

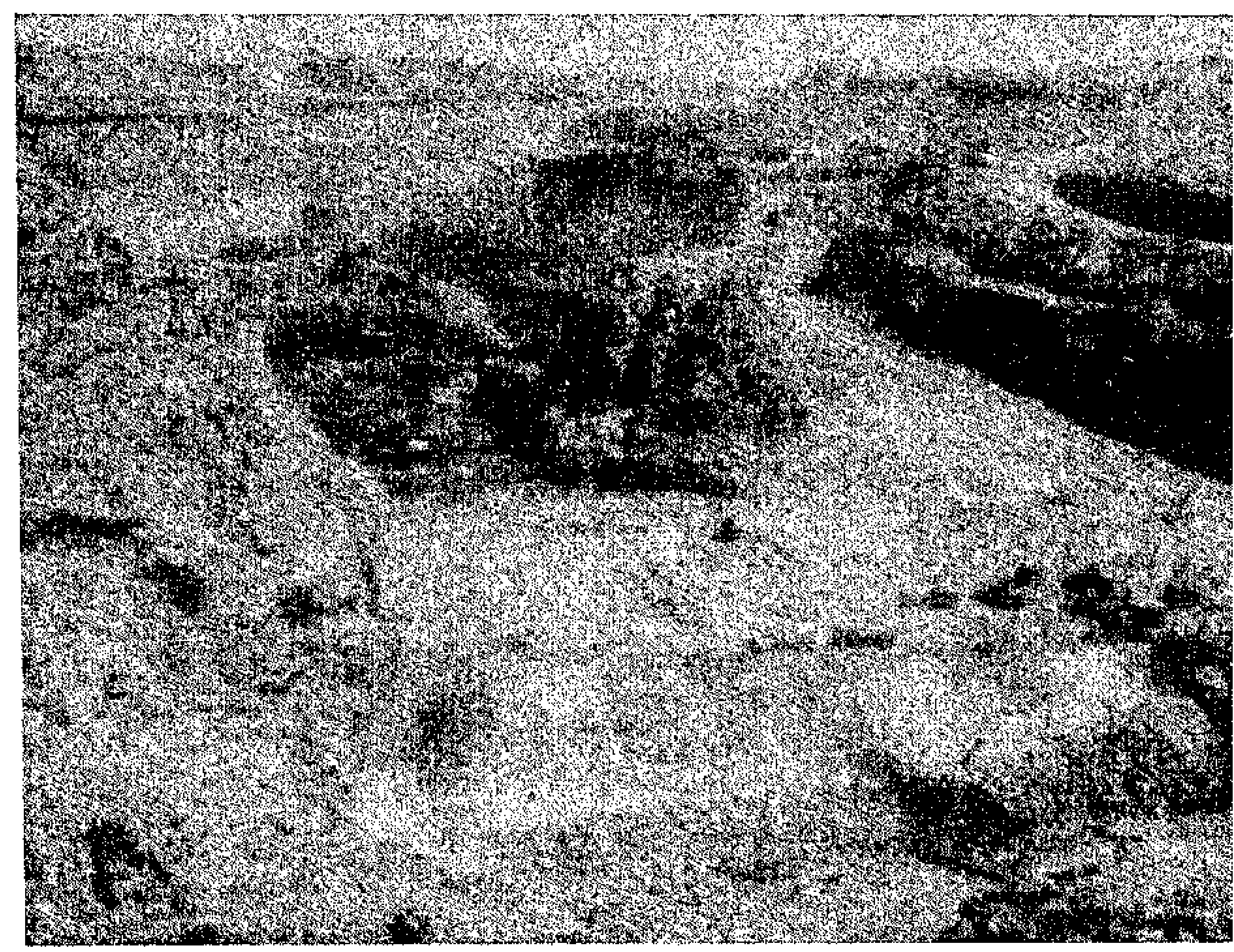




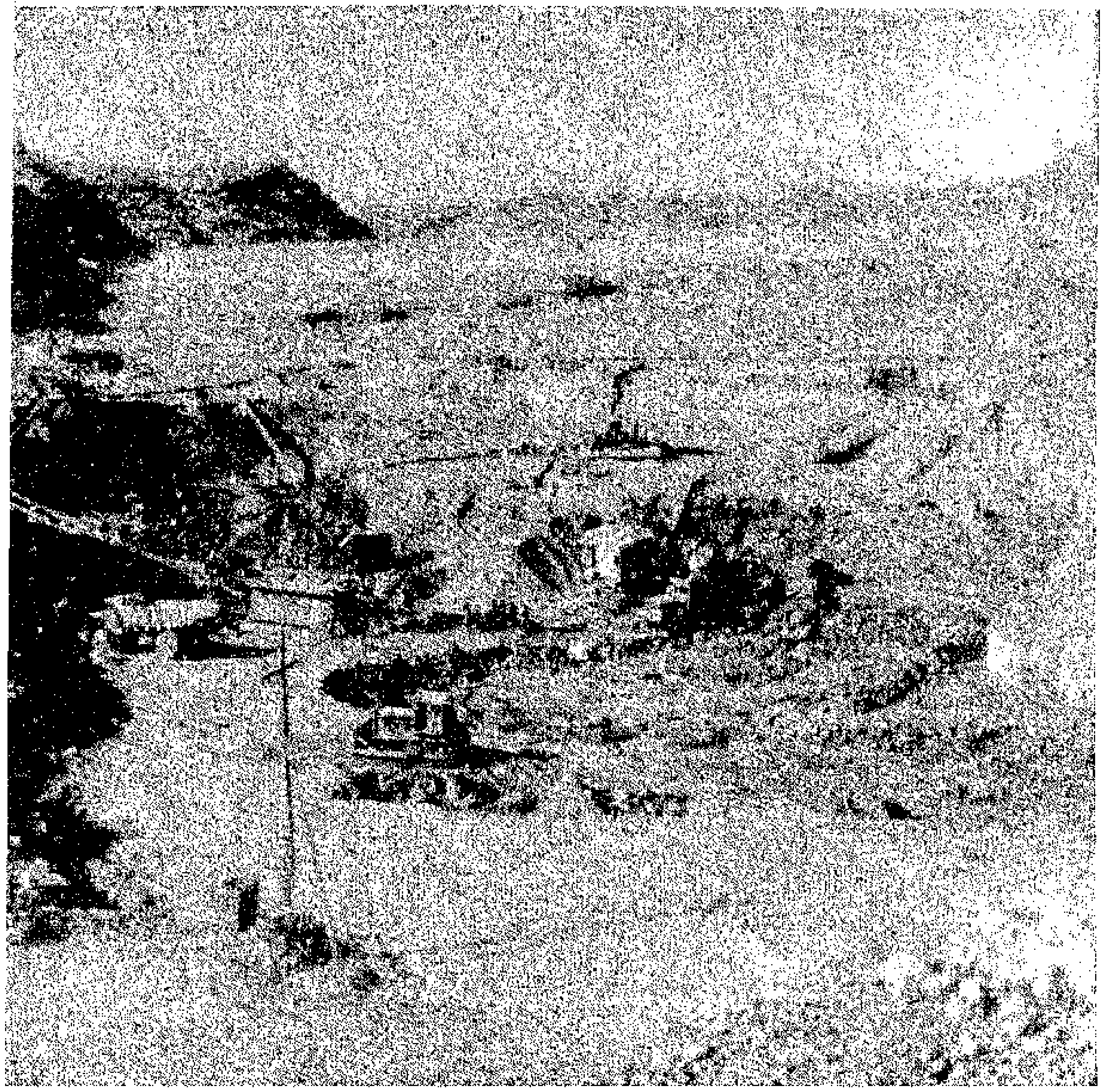
Blasting of the virgin rock plug at the Diversion Canal Outlet.

D. S. Temporary Sand Cofferdam after completion.





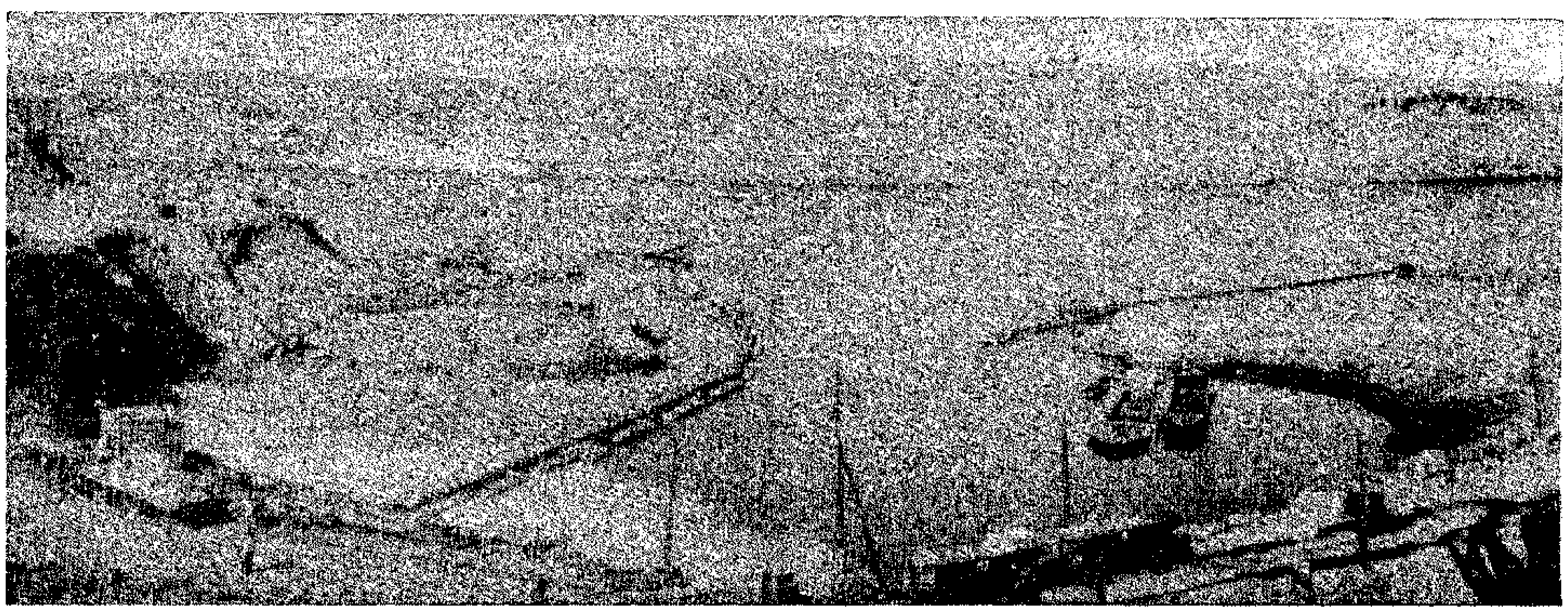
Sand filling in the D.S. Temporary Cofferdam by 25 tons trucks.



Excavation of soft material in Upstream Canal

2nd U.S. Temporary Sand Cofferdam under construction

Excavation of Canal exit by Suez Canal dredger



Filling of Downstream Temporary Sand Cofferdam by hydromechanisation & removal of Earth Cofferdam by floating dredgers

## THE INTAKE STRUCTURE

Each tunnel has two inlets, a lower one at the same level of the canal bed, and an upper intake 38 m. higher known as the Intake Structure which is composed of 6 sections and connected with the tunnel trunks by means of inclined tunnels. The lower inlets will be used temporarily during the construction period of the project, then they will be permanently plugged with concrete and the upper Intake Structure is used.

The Intake Structure was constructed simultaneously with the construction of lower tunnels and shafts for the gates which will control the discharge through the lower inlet openings of the tunnels. After filling the reservoir and plugging the lower inlets of the tunnels with concrete, the gates will be shifted to the upper intakes on top, and their winches transferred from the temporary trestles to the intake superstructure above the design level of the lake. This arrangement is used to decrease the pressure on the gates thus reducing their weig t and facilitating their operation.

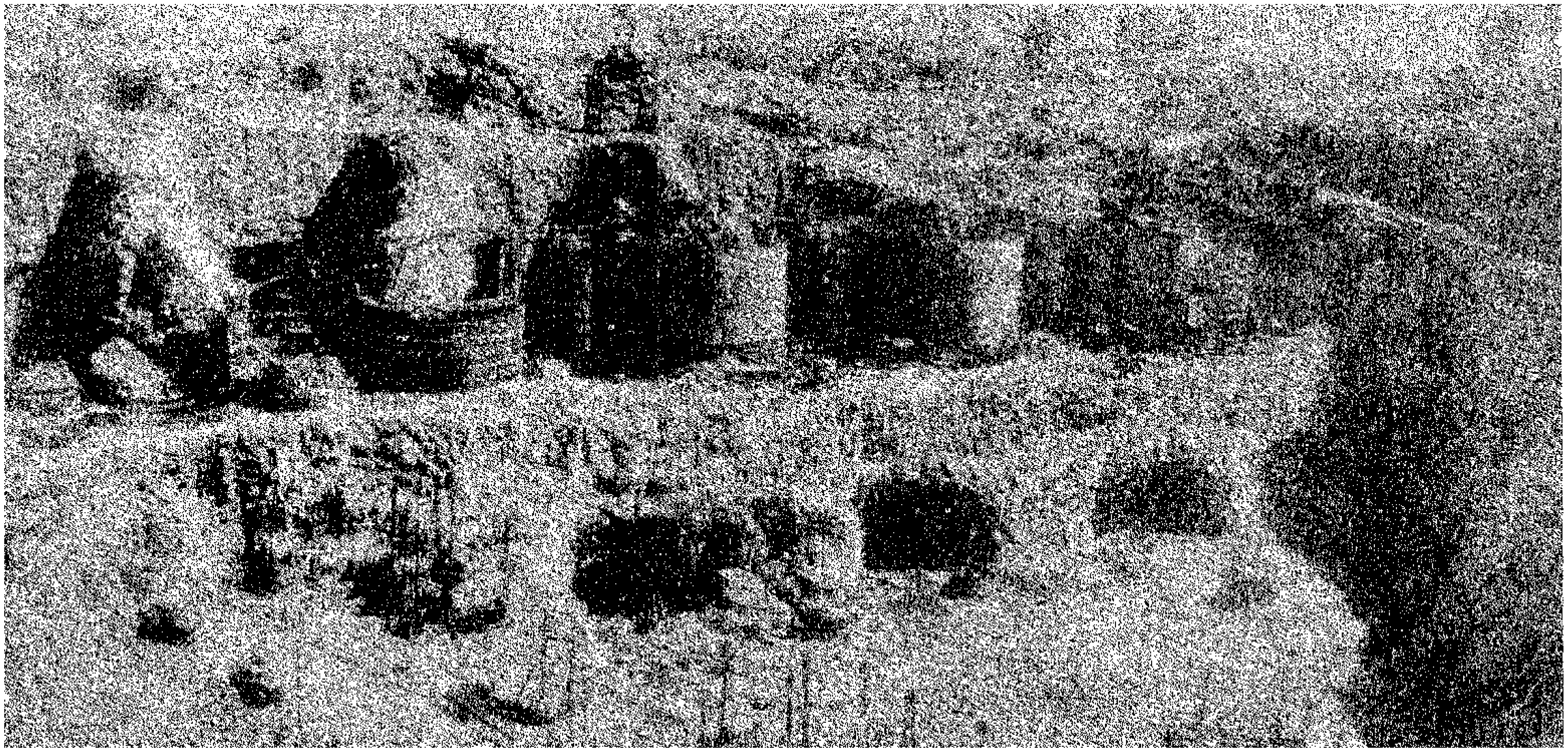
The total volume of concrete cast in the Intake Structure is 93,000 cu. m.

## THE HYDRO-ELECTRIC POWER STATION

The construction of the power house started on the 9 January 1963 when President Nasser cast the first charge of concrete in its foundation. Now the reinforced concrete power house has reached the height of 40.5 m above the lowest part excavated in its foundation. Its total length is 293 m and its width from the tunnel exits to the end of the draft tube apron is 75.5 m.

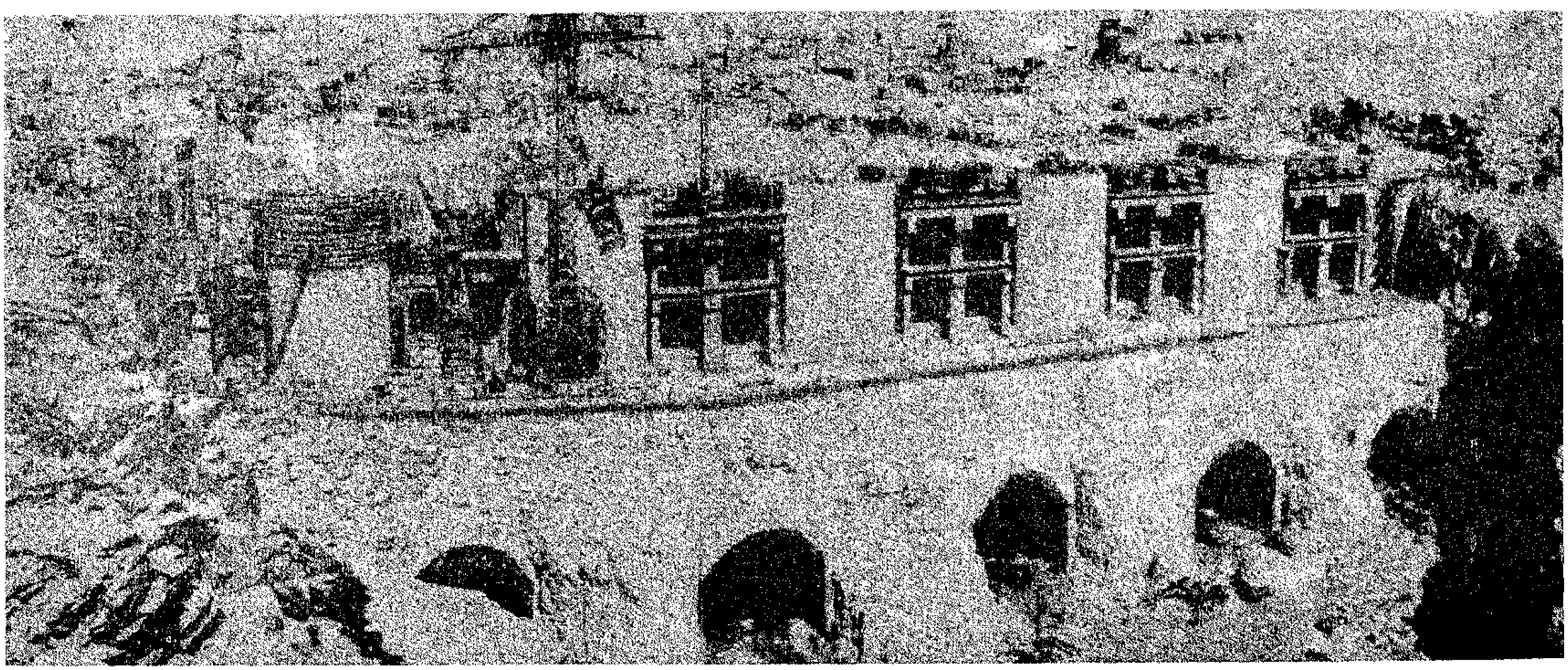
The total volume of concrete cast in the power house till the end of April 1964 was 247,000 cu.m. The monthly rate of casting increased gradually from 1,080 cu.m. in April 1963 to 33,600 cu.m. in December 1963 and the maximum daily rate was 1,620 cu.m. in 17 December 1963.

Concreting of Intake Structure together with excavation of pockets & Upstream Canal



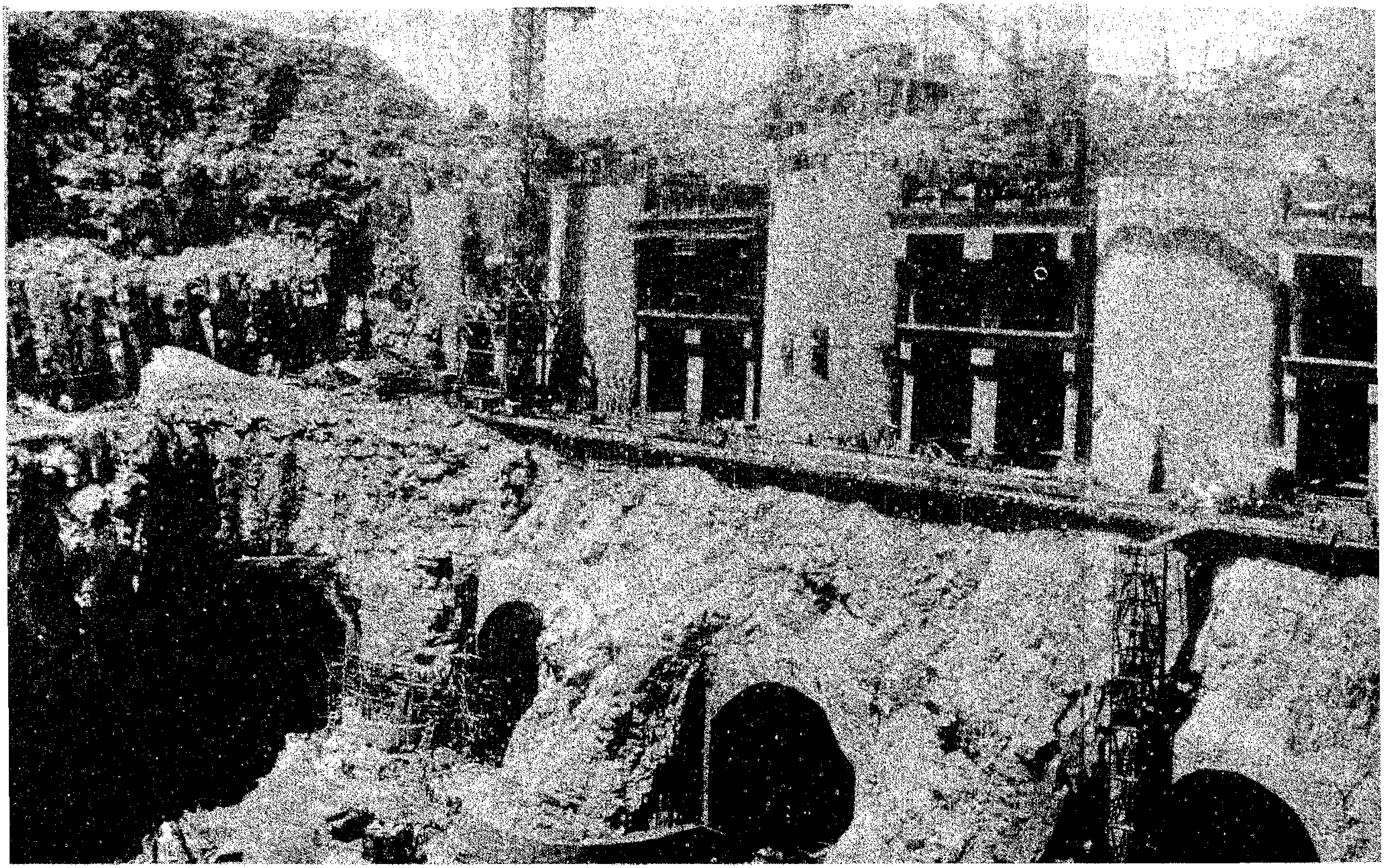
Concreting of Intake Structure.
Seen Inlet of Tunnels.

Intake Structure till
level 138,50.
Seen visors of Inclined
Tunnels No. 5,6.

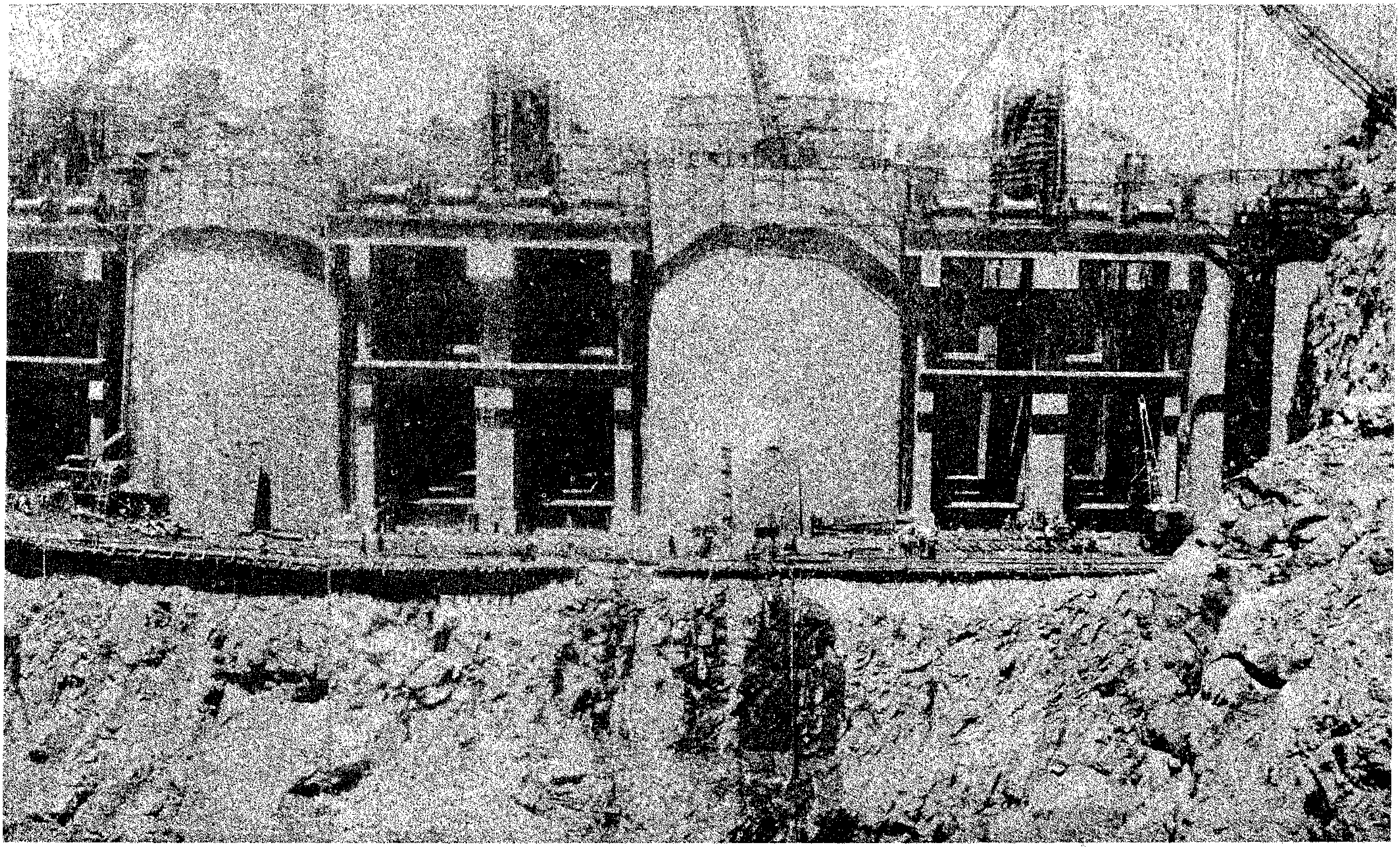


Erection of hoisting machines of the Intake Structure. Concreting of other sections

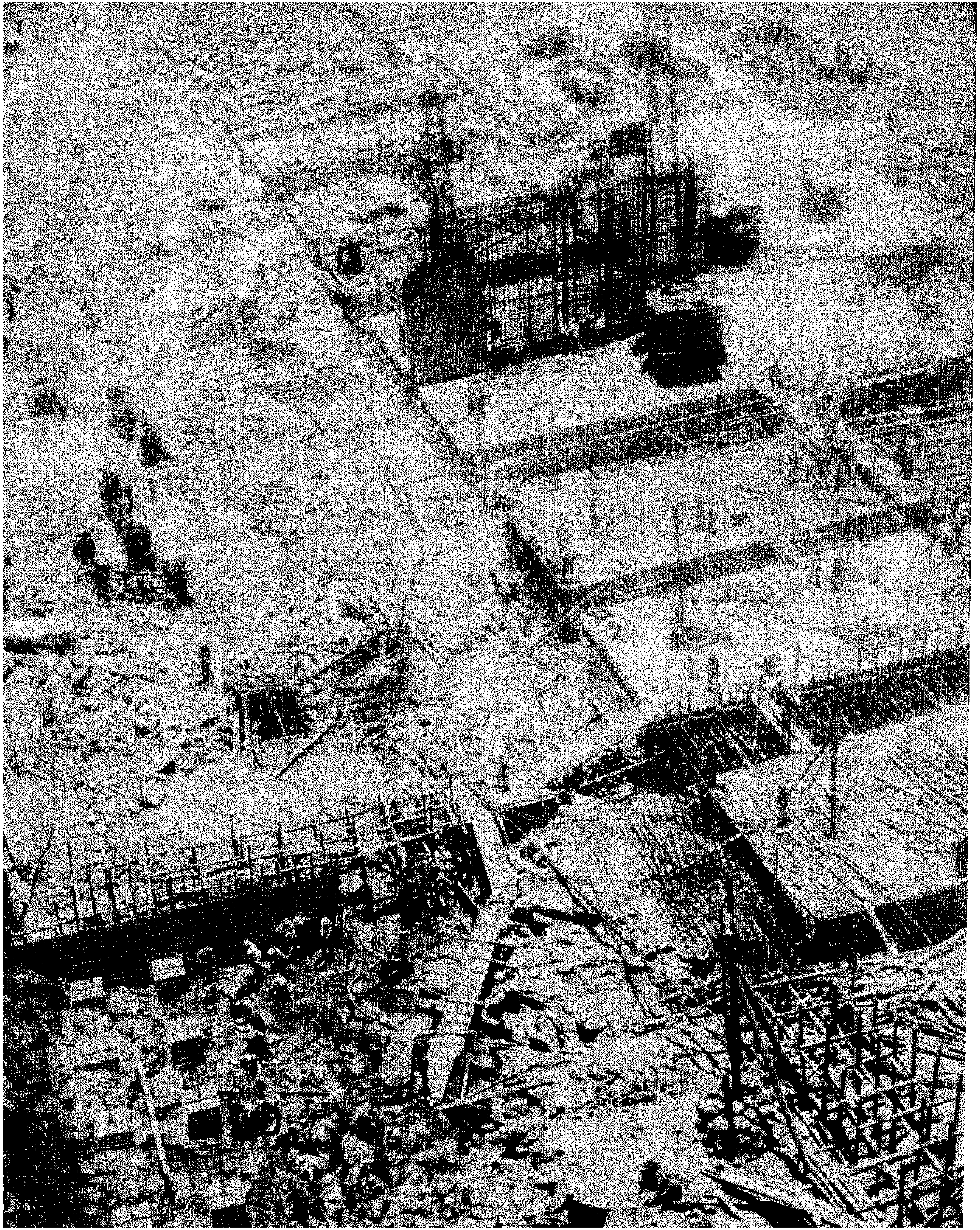
Construction works in the Intake Structure at night.



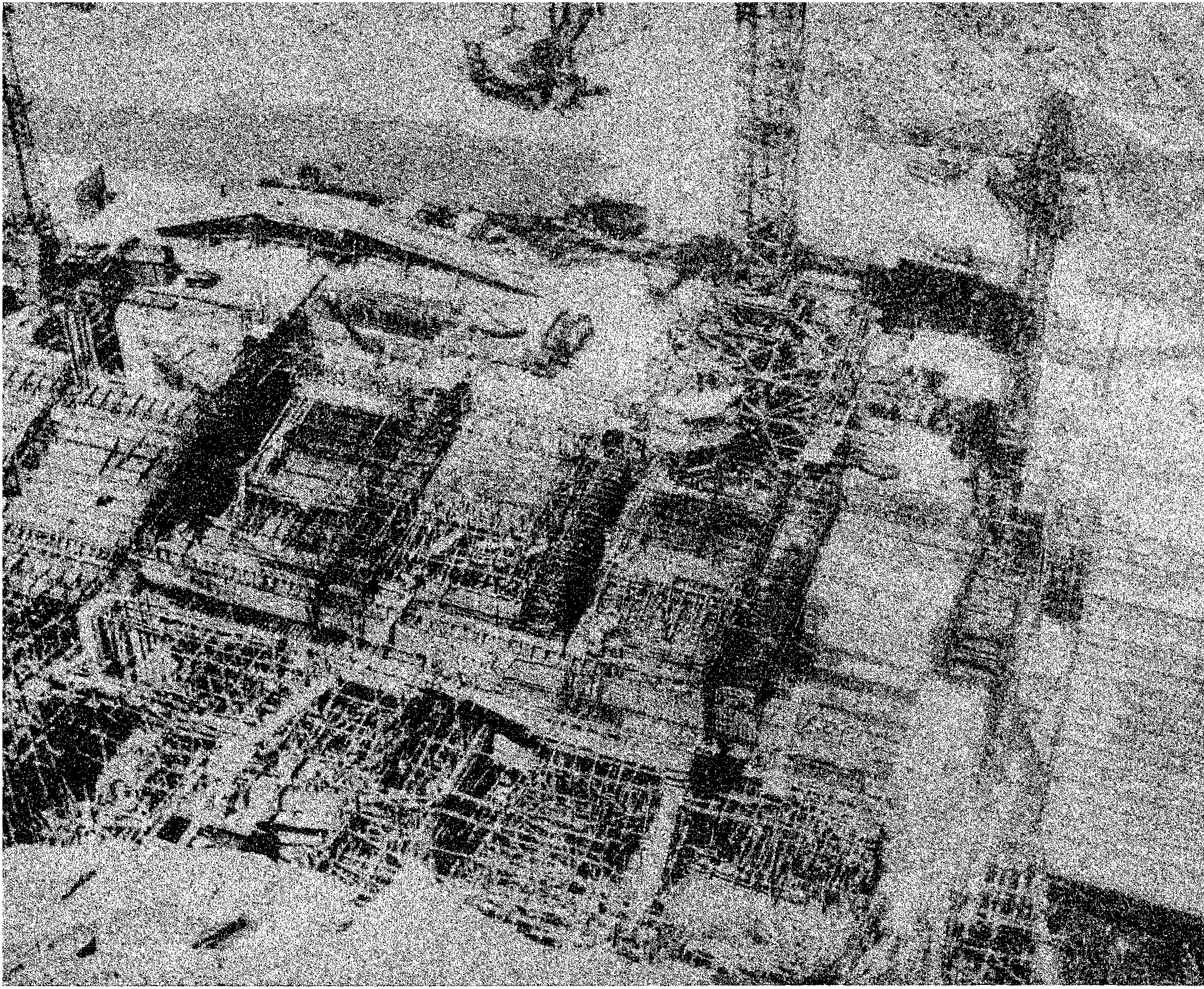
2nd Stage concrete works



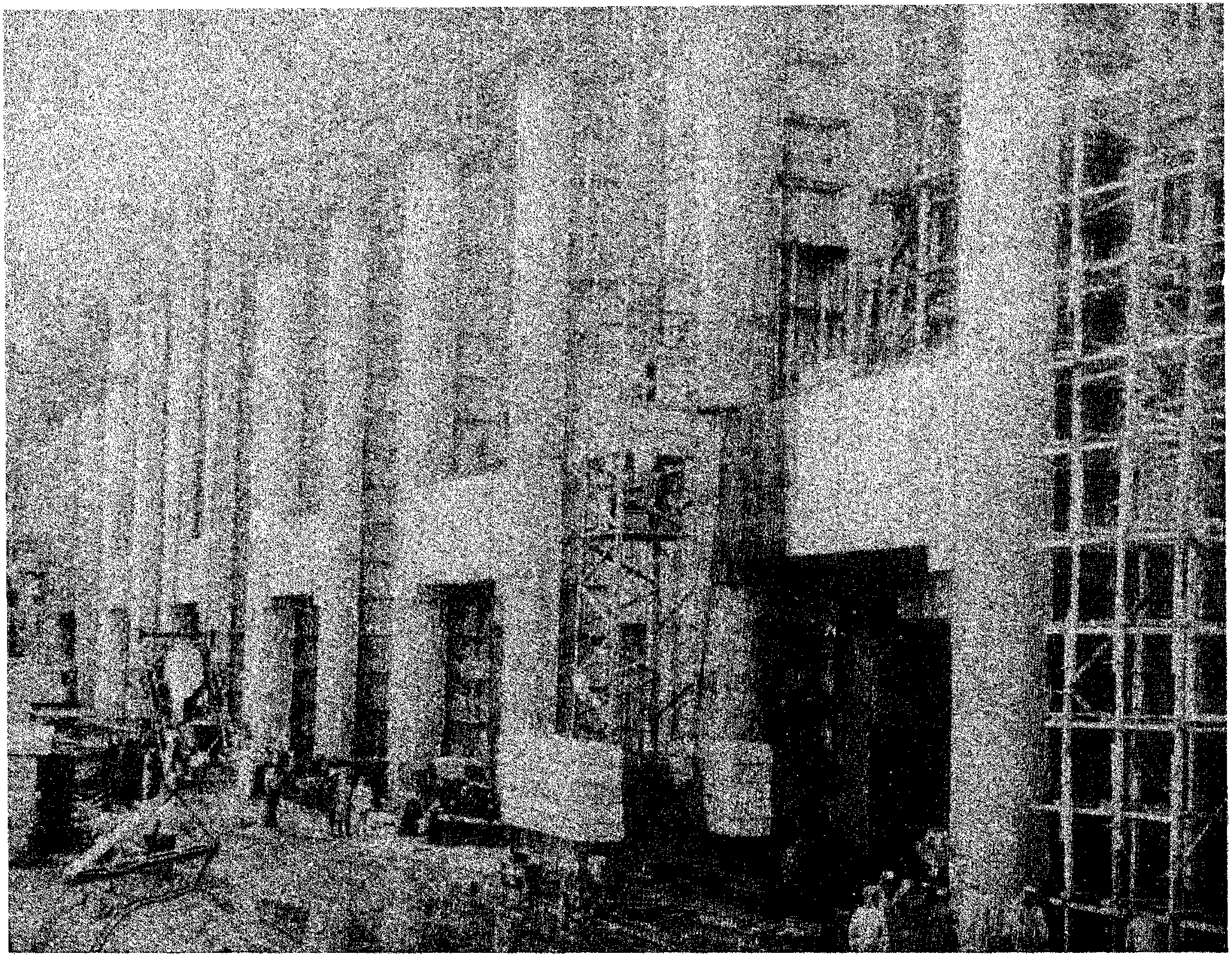
starting in the Intake Structure.



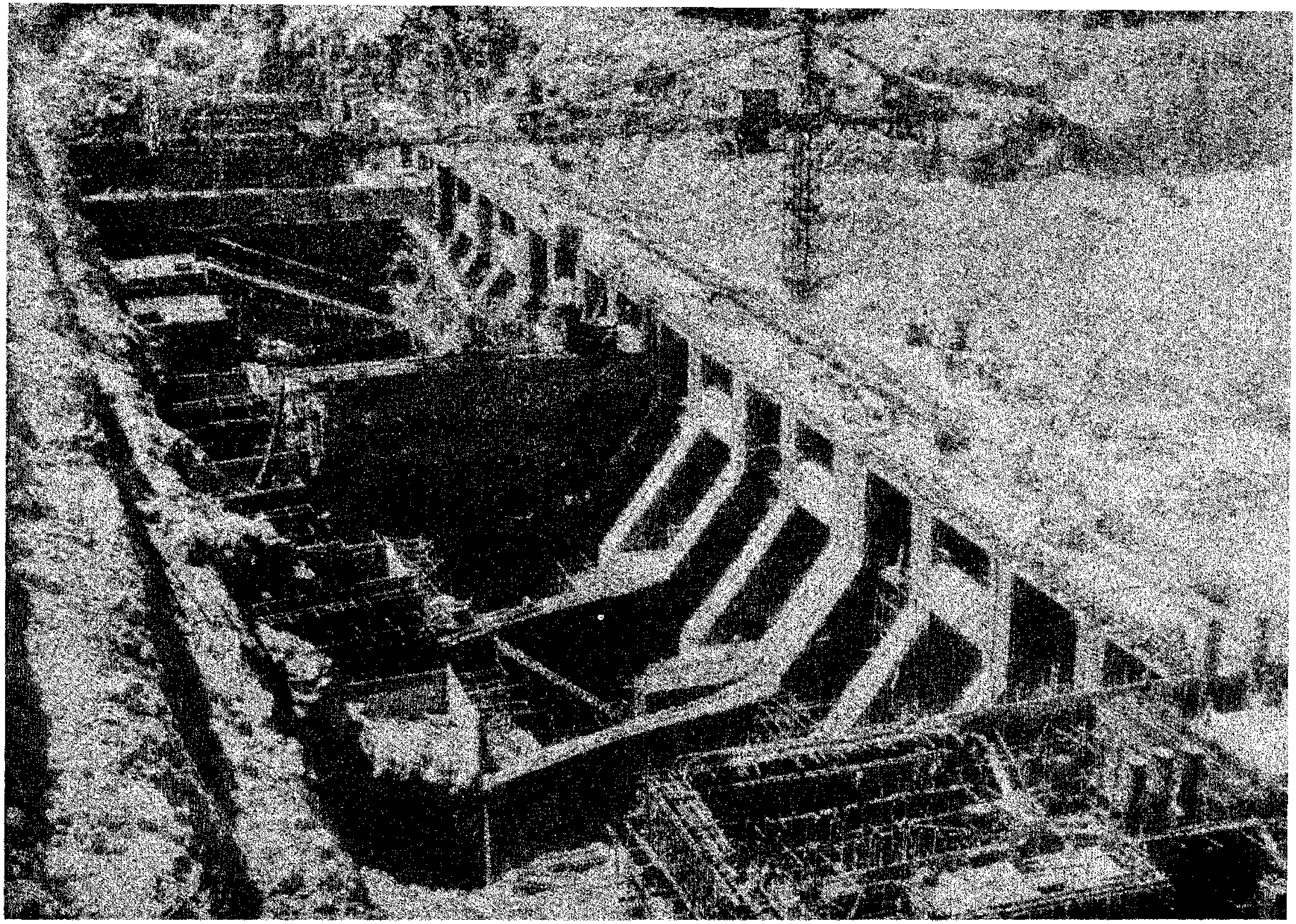
General view of Hydro Power Station site, showing steel reinforcement of one of the piers and excavation works in the foundation pit.



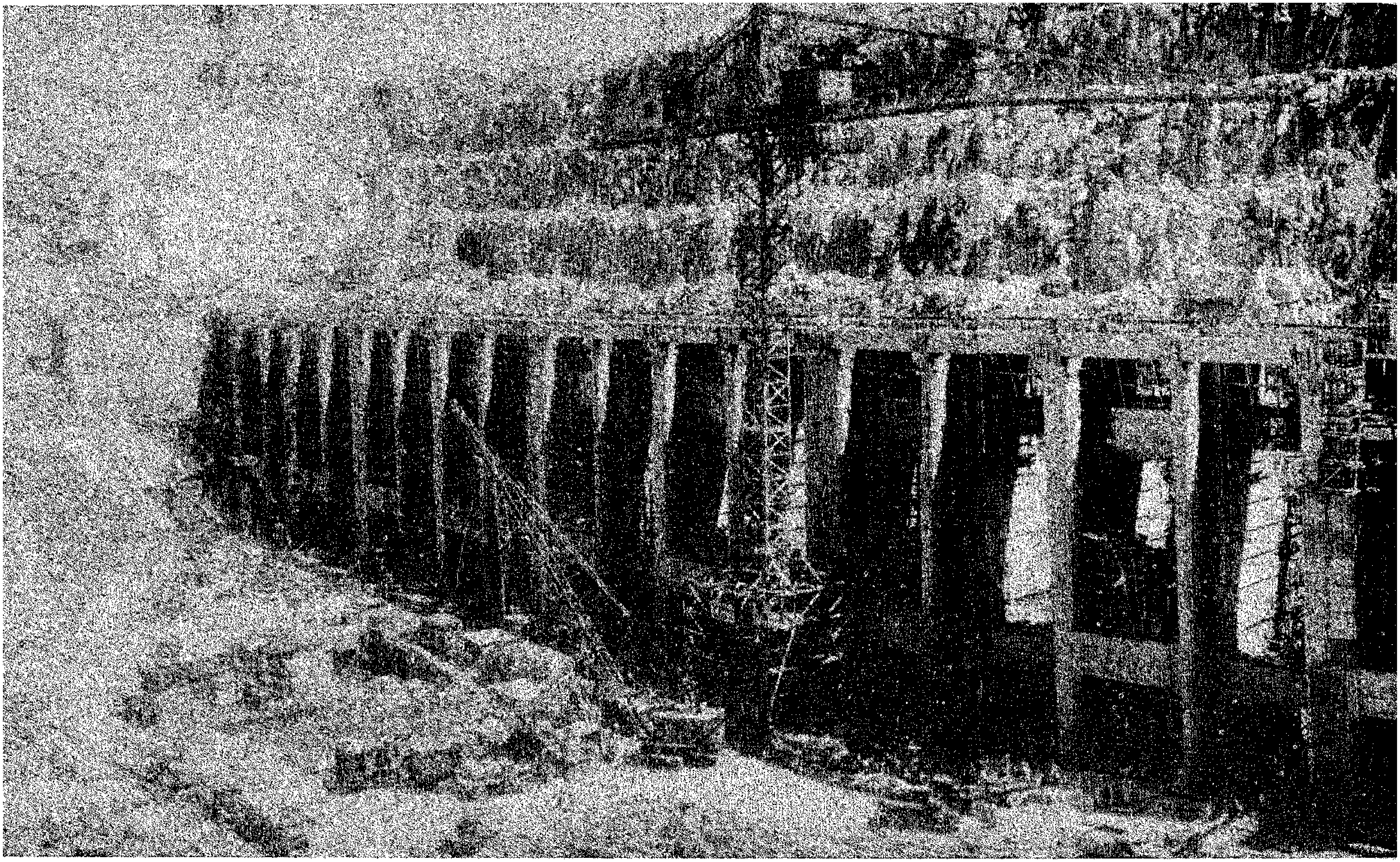
Progress of work in the construction of the Power House, concrete pumps and different types of cranes are used in casting concrete.



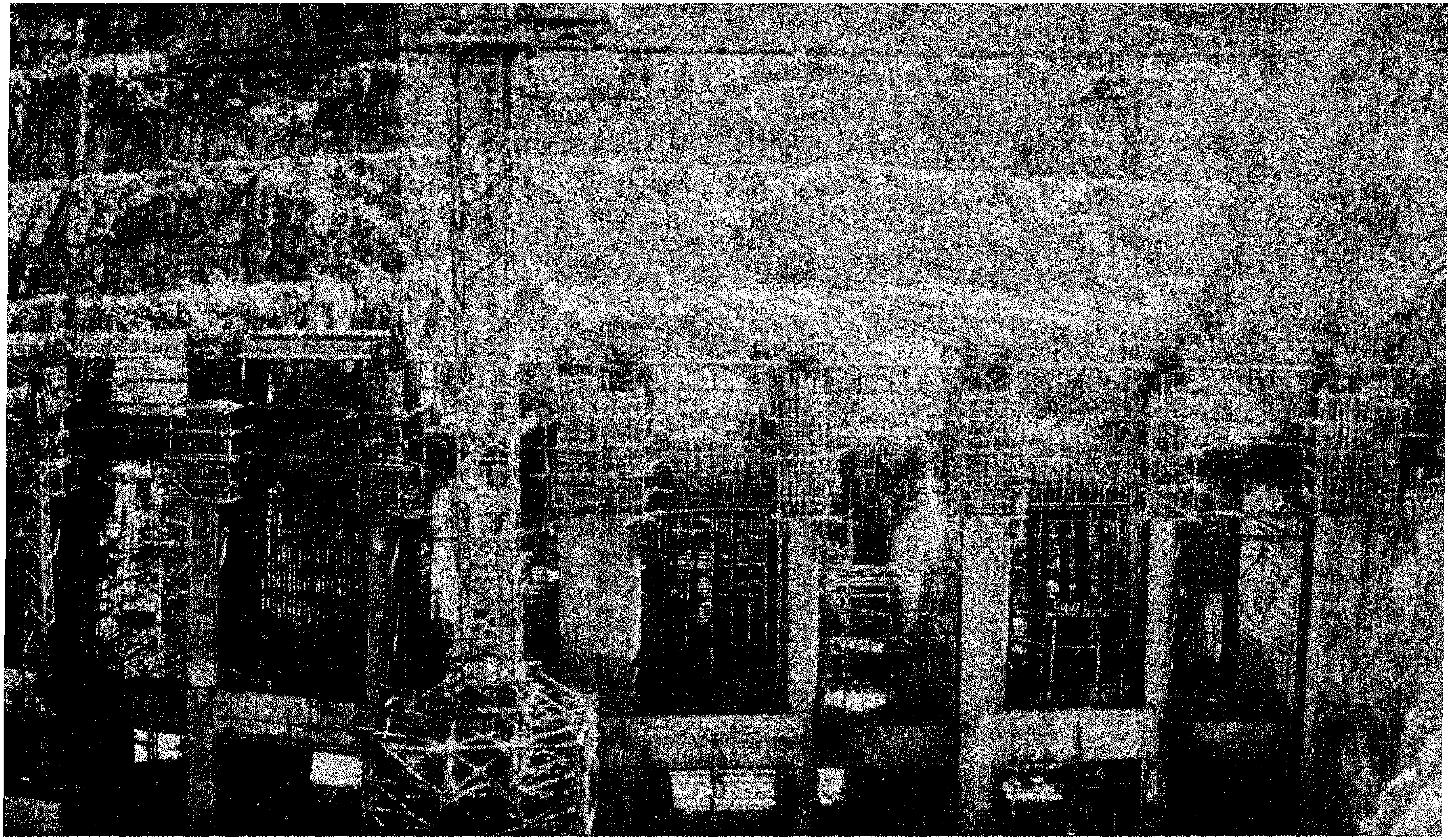
General view of the Power House during construction, seen on 25/2/1964.



The Power House as shown on 31 / 3/ 1964.
Assembly Bay seen at right



The Power House and the 1st stage



works nearly completed

# TUNNELS

Six main tunnels have been constructed in the diversion passage between the U.S. and D.S. Canals. Their average length is 282 m. per tunnel with a circular cross section of 15 m in diameter and a reinforced concrete lining of a minimum thickness of one meter. The tunnels can pass the flood discharge of 11,000 cu.m. per sec. (about one billion cu.m./day) at an average velocity of 12 meters per second.

Before discharging into the power house, each tunnel is divided into two branches. These branches have rectangular sections 22×7.5 m feeding both the turbines and the spillway.

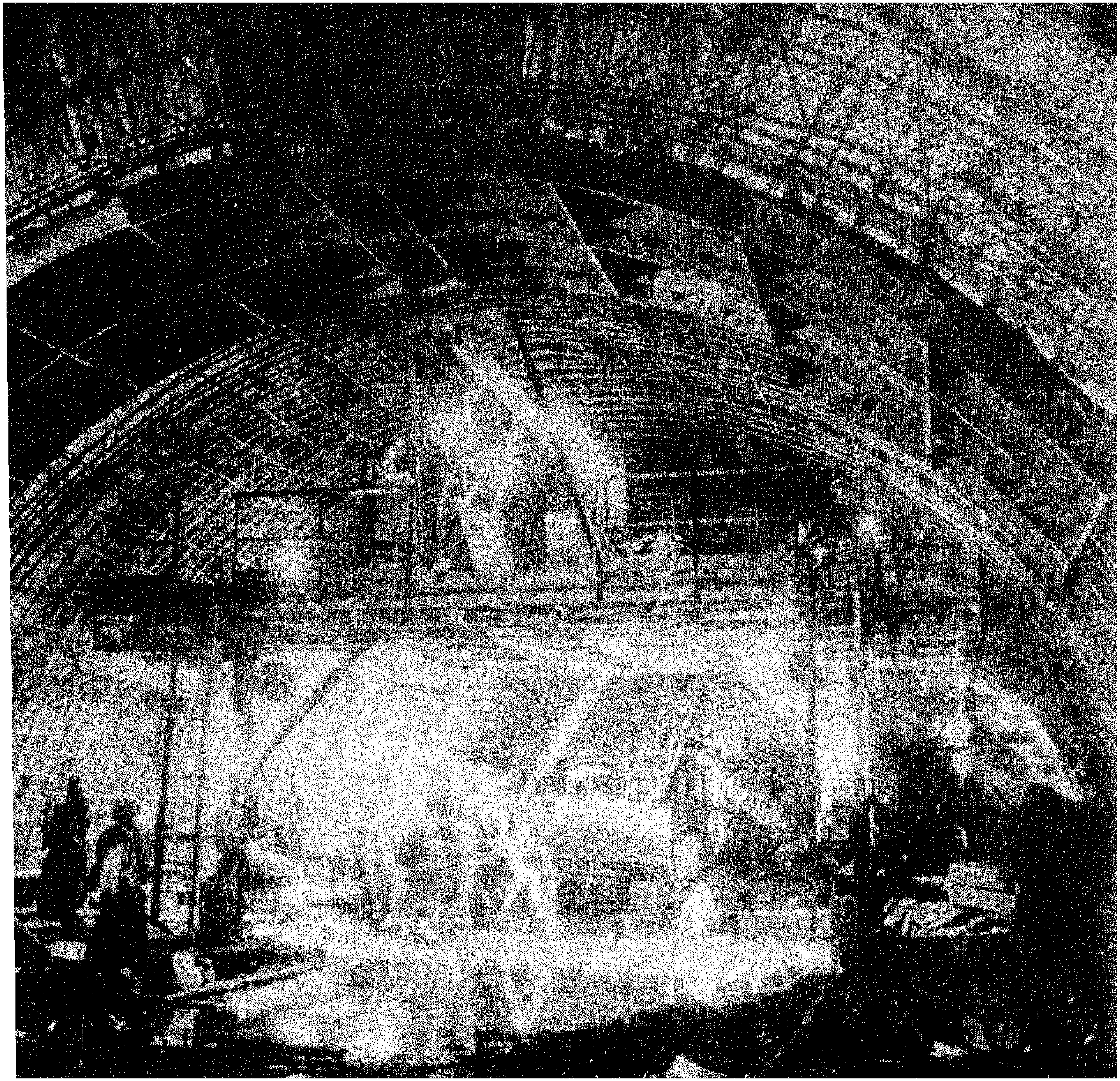
Since the lower perimeter of the tunnels is at the same level of the bed of the U.S. and D.S. canals, a transport tunnel 603 m long, 10 m wide and 7.5 m high was constructed, to intersect the paths of the six main tunnels. This created approaches for excavating the upper benches of the tunnels.

The upper bench of each tunnel is then excavated and lined with reinforced concrete. Then the lower bench is excavated and lined. Pneumatic perforators used to drill the blast holes of the upper benches and rotary machines for the lower benches. The excavated rock was removed after blasting by means of different sized excavators and dumpers. The concrete reinforcement was shaped and welded in the mechanical erection yard and transported to the tunnels. Concrete was brought from the batching plant in special concrete trucks and cast in place by means of concrete pumps. Access to tunnels was through the transport tunnel until outlets to the U.S. and D.S. canals were available. The transport tunnel was then closed with reinforced concrete and lower bench was completed.

The inclined tunnels 5 and 6 which connect the tunnels 5 and 6 with the same sections of intake structure were constructed in the first stage of the project while the remaining four are left for the second stage.

The work in tunnels necessitated the construction of 4 ventilation shafts through the rock above the tunnels and the installation of a ventilation system, together with networks for electricity, water and compressed air, which were continuously extended according to the progress of excavation.

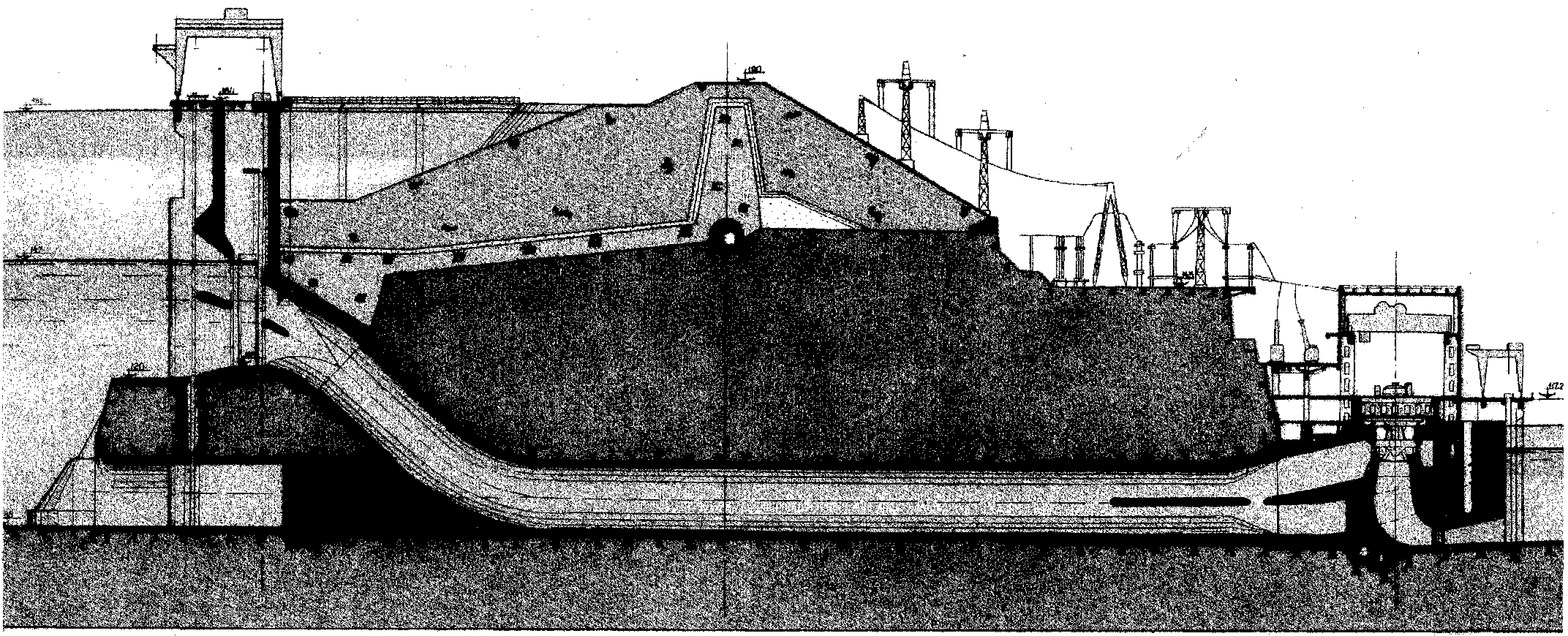
Excavation of the tunnels started in August 1961. The rate of excavation increased gradually until it reached 60,000 cu.m. during August 1963 with a maximum daily rate of 3,800 cu.m. on 25 October 1963. The total volume of rock excavated from the tunnels was 614,000 cu.m. Concrete lining of tunnels started in November 1962. The rate of concrete casting increased gradually until it reached 40,000 cu.m. in April 1964 and the maximum daily rate was 2,170 cu.m. on March 31, 1964. The total volume of concrete cast in the tunnels is 279,700 cu.m. Sixteen gates, together with their operating mechanisms were erected in the first stage.

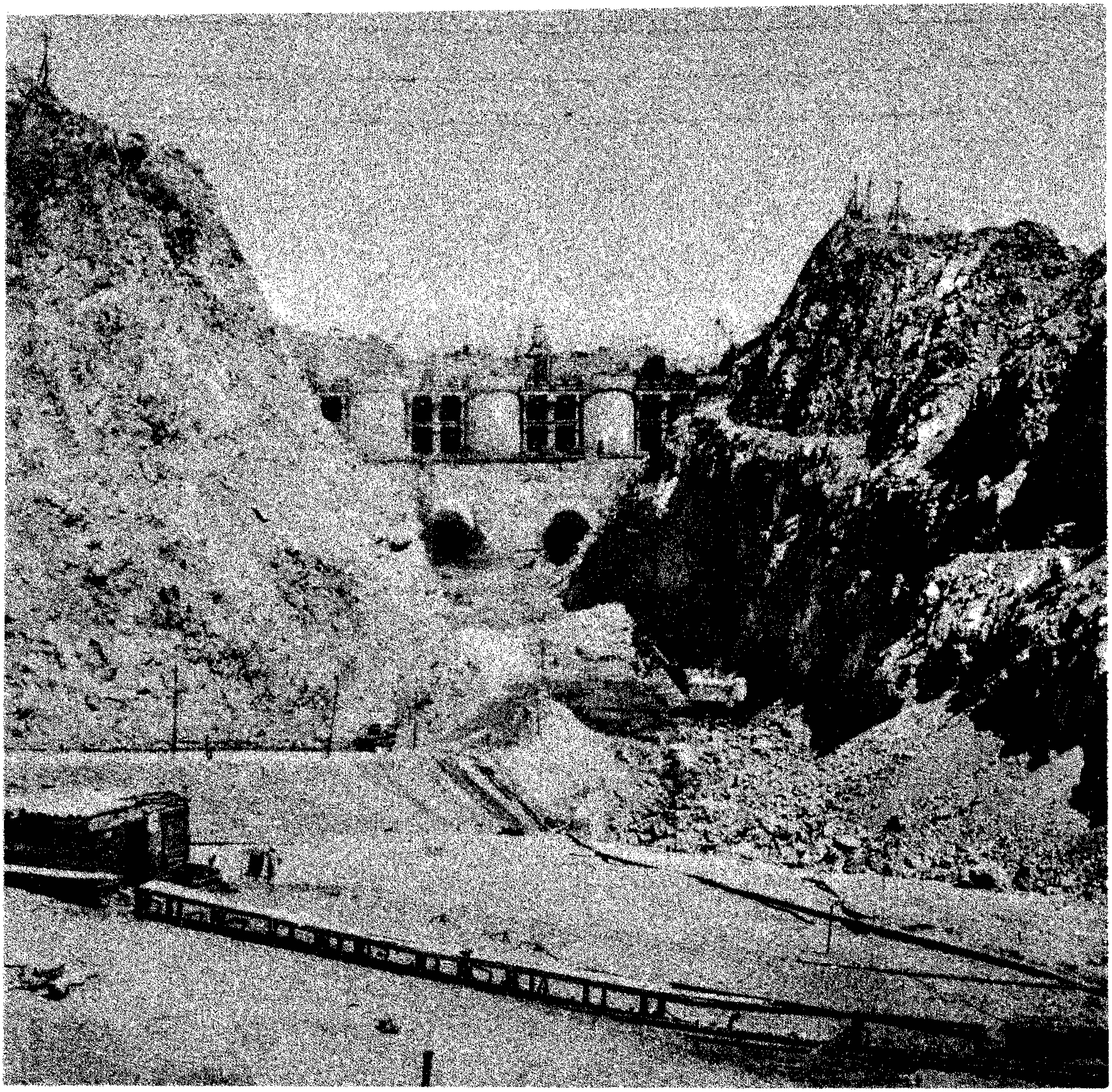


Upper bench of Tunnel. Seen reinforcement steel & metallic shuttering

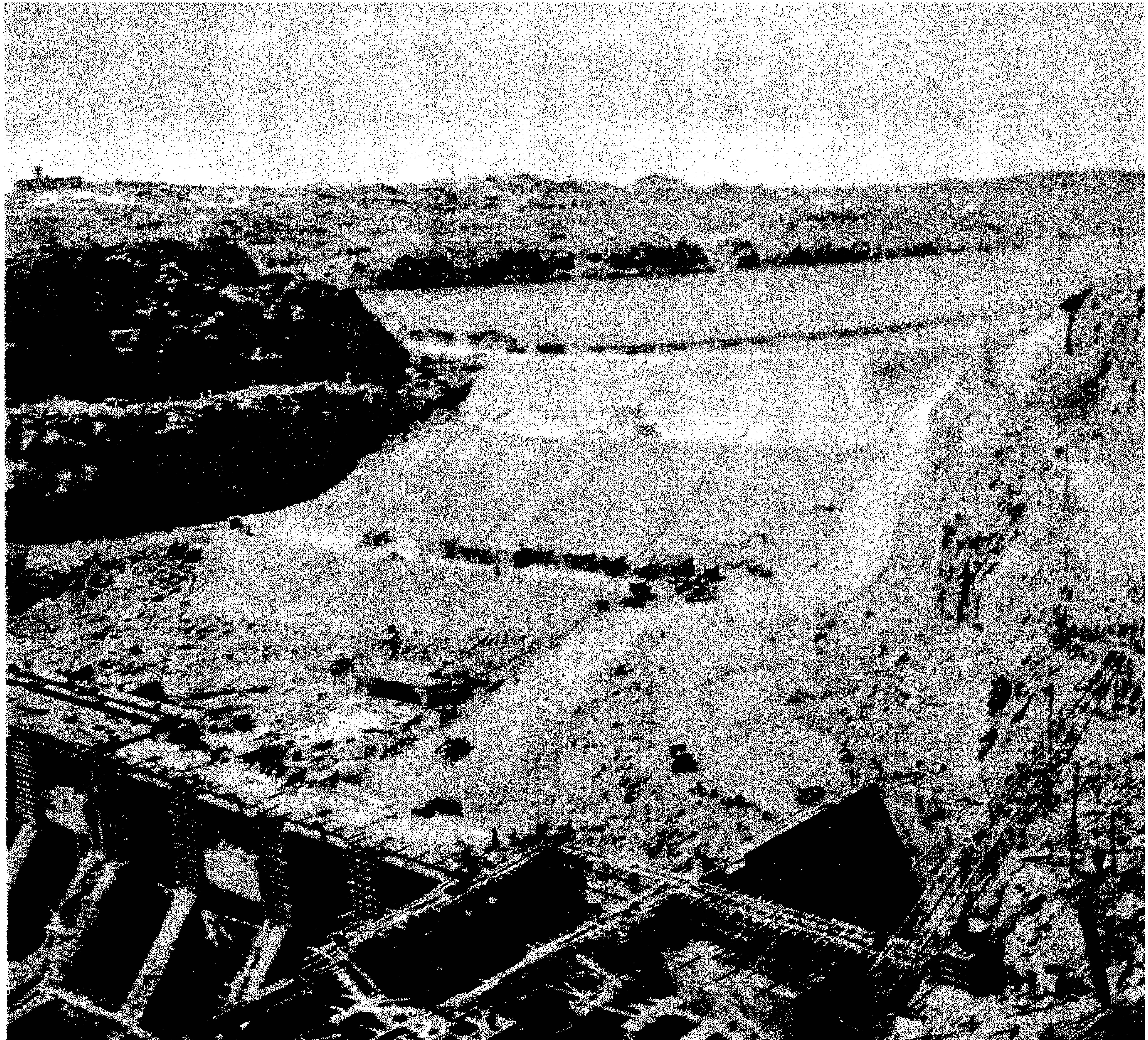
# SPILLWAY STRUCTURE

SCALE 1:500





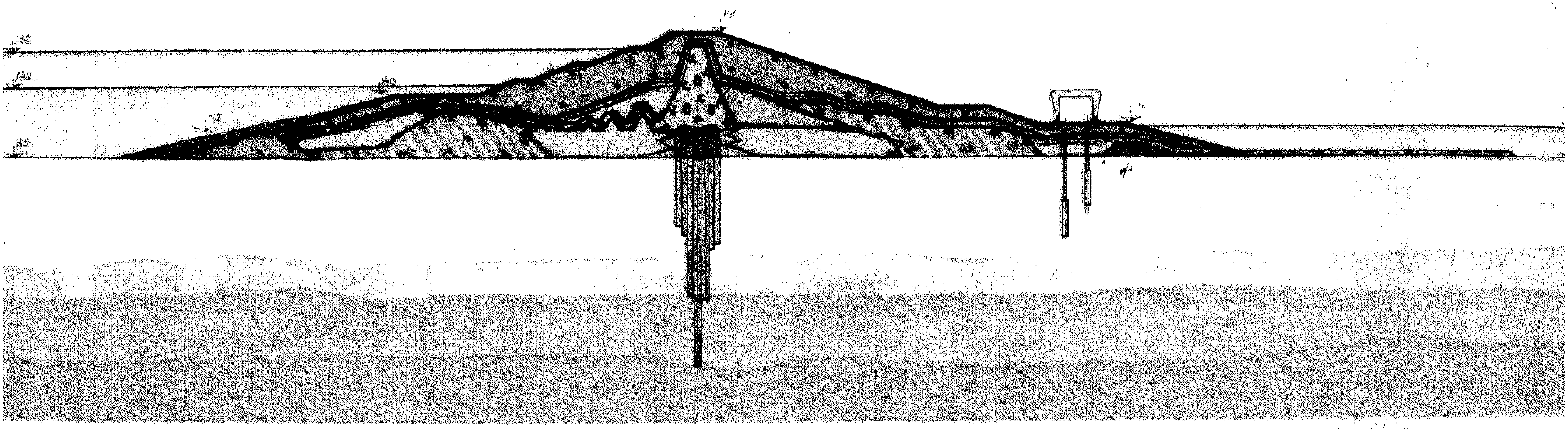
Upstream Canal



Downstream canal

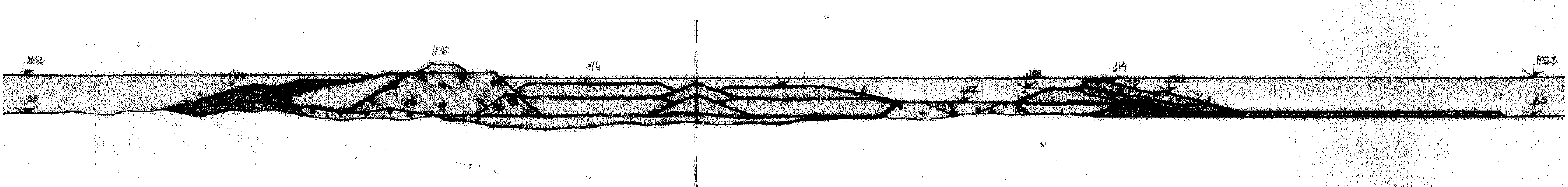
## HIGH DAM.

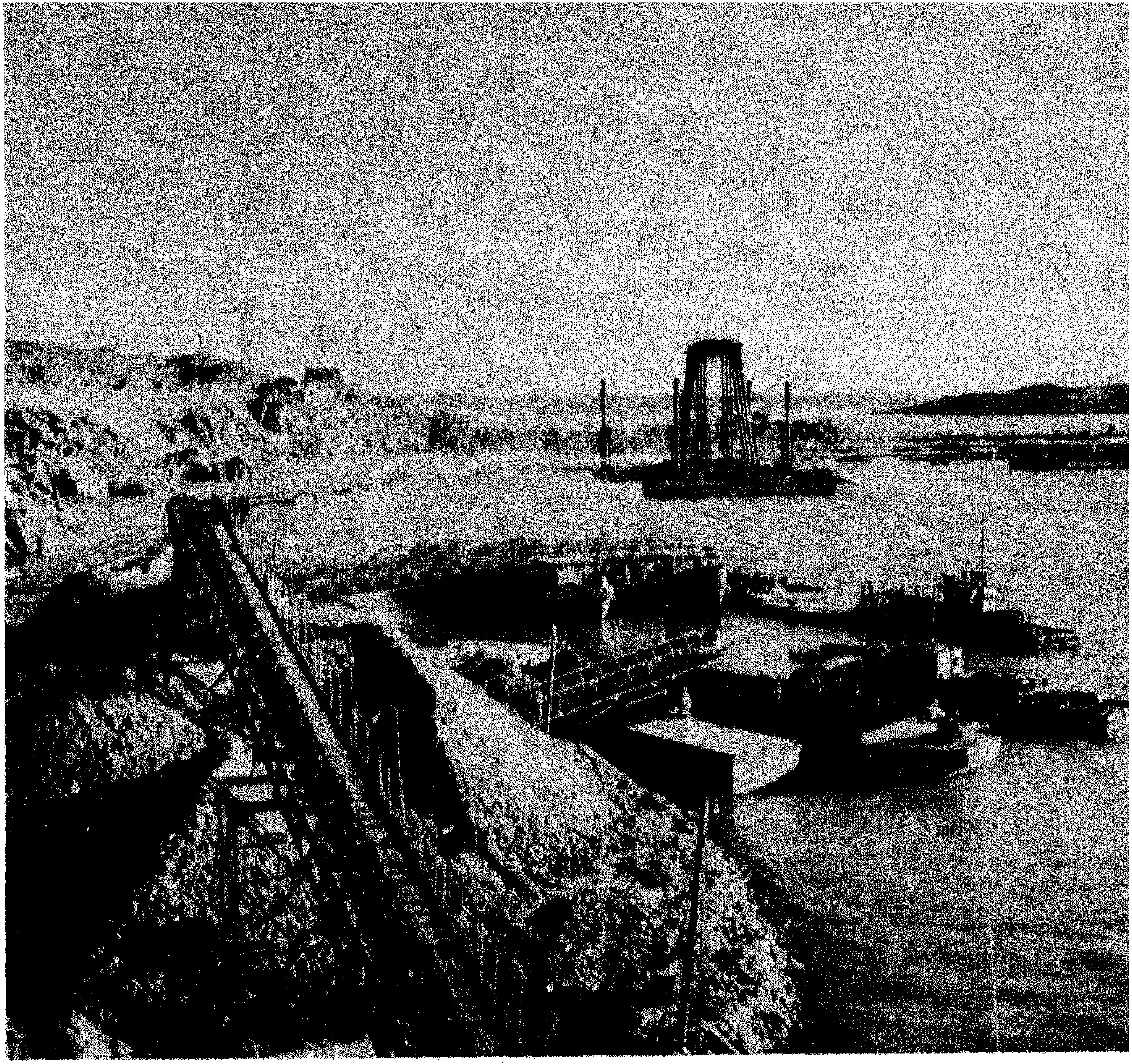
Scale 1:2000



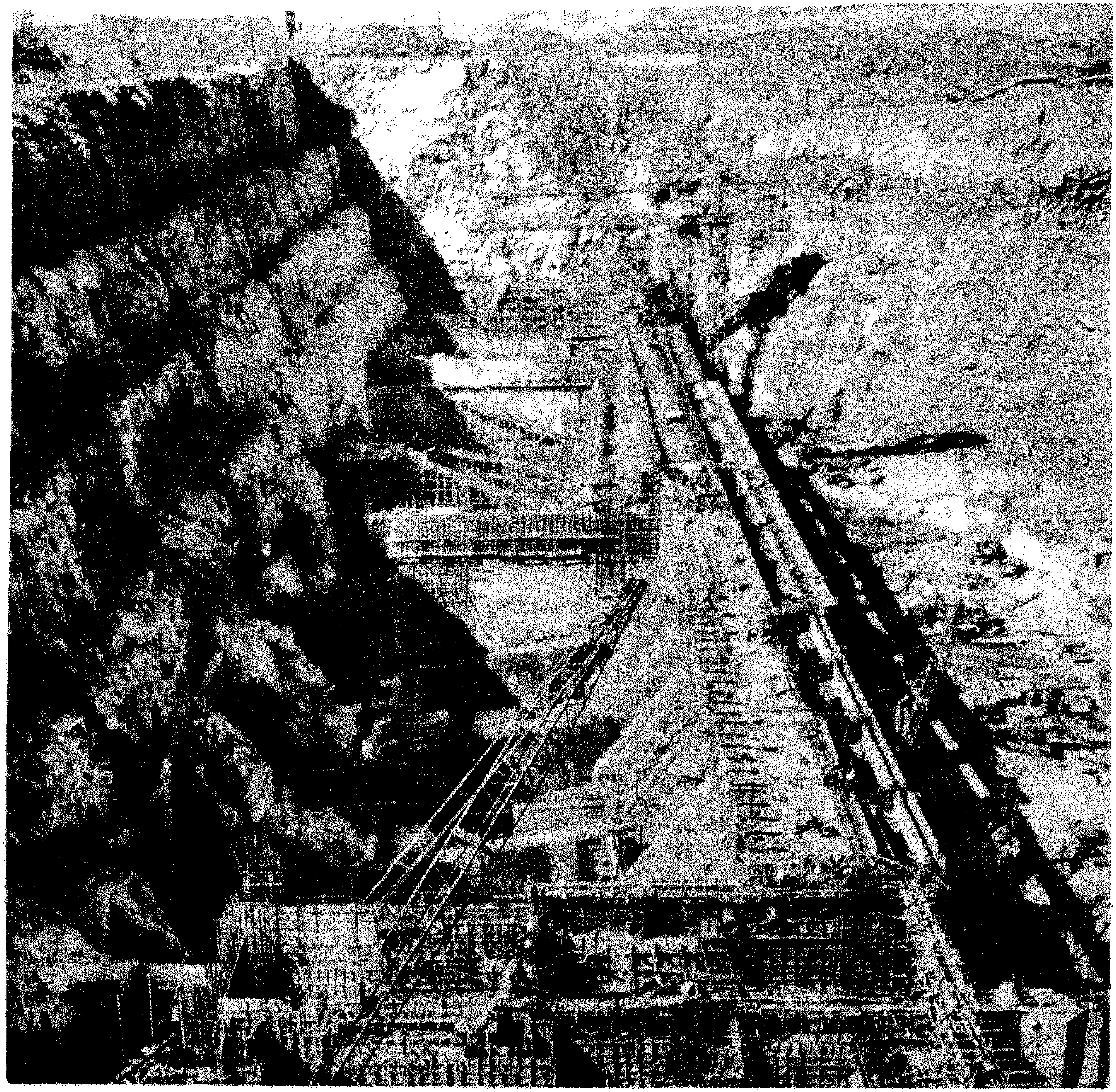
## 1st STAGE HIGH DAM

Scale 1:2000

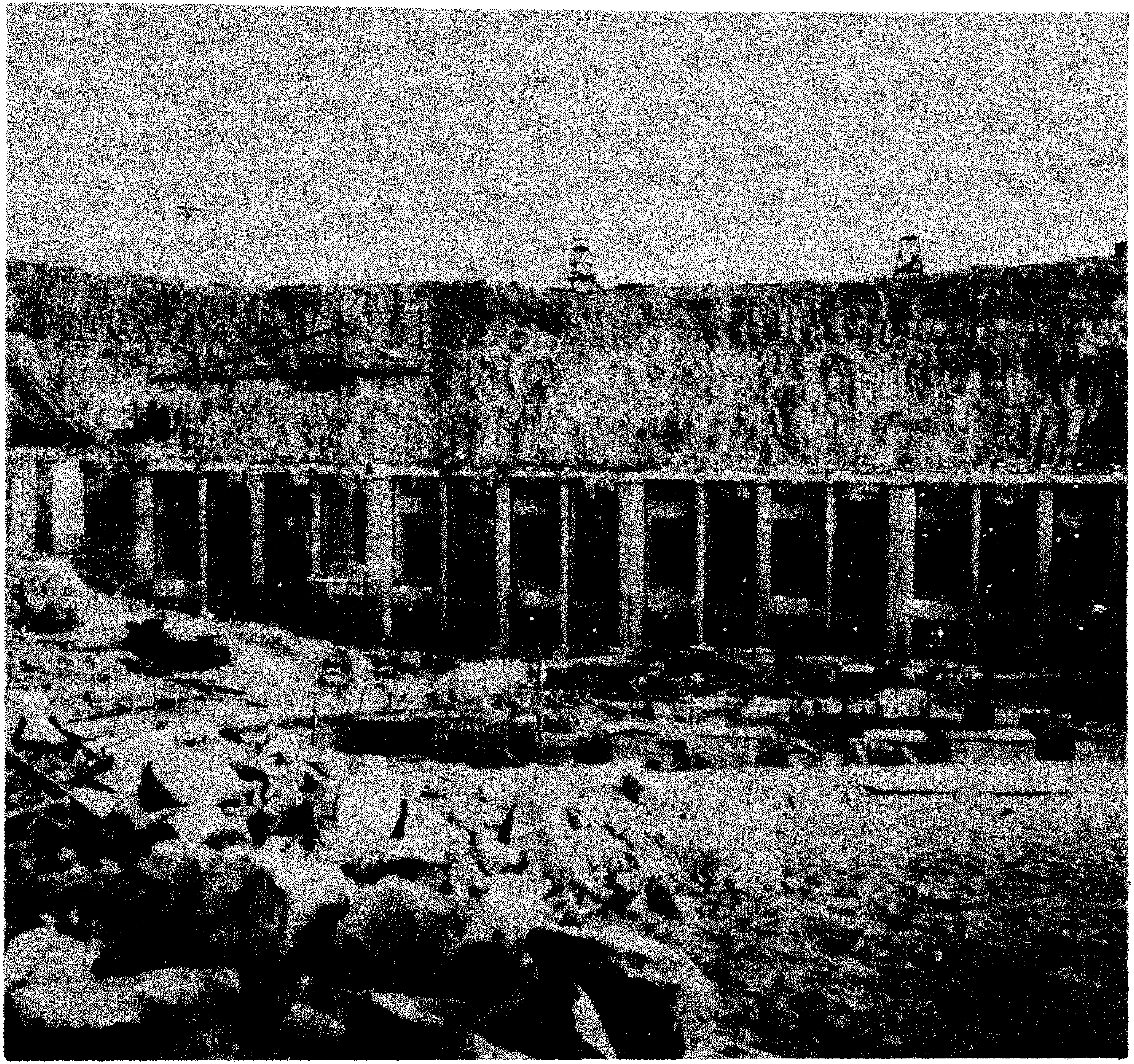




Execution of works in dam



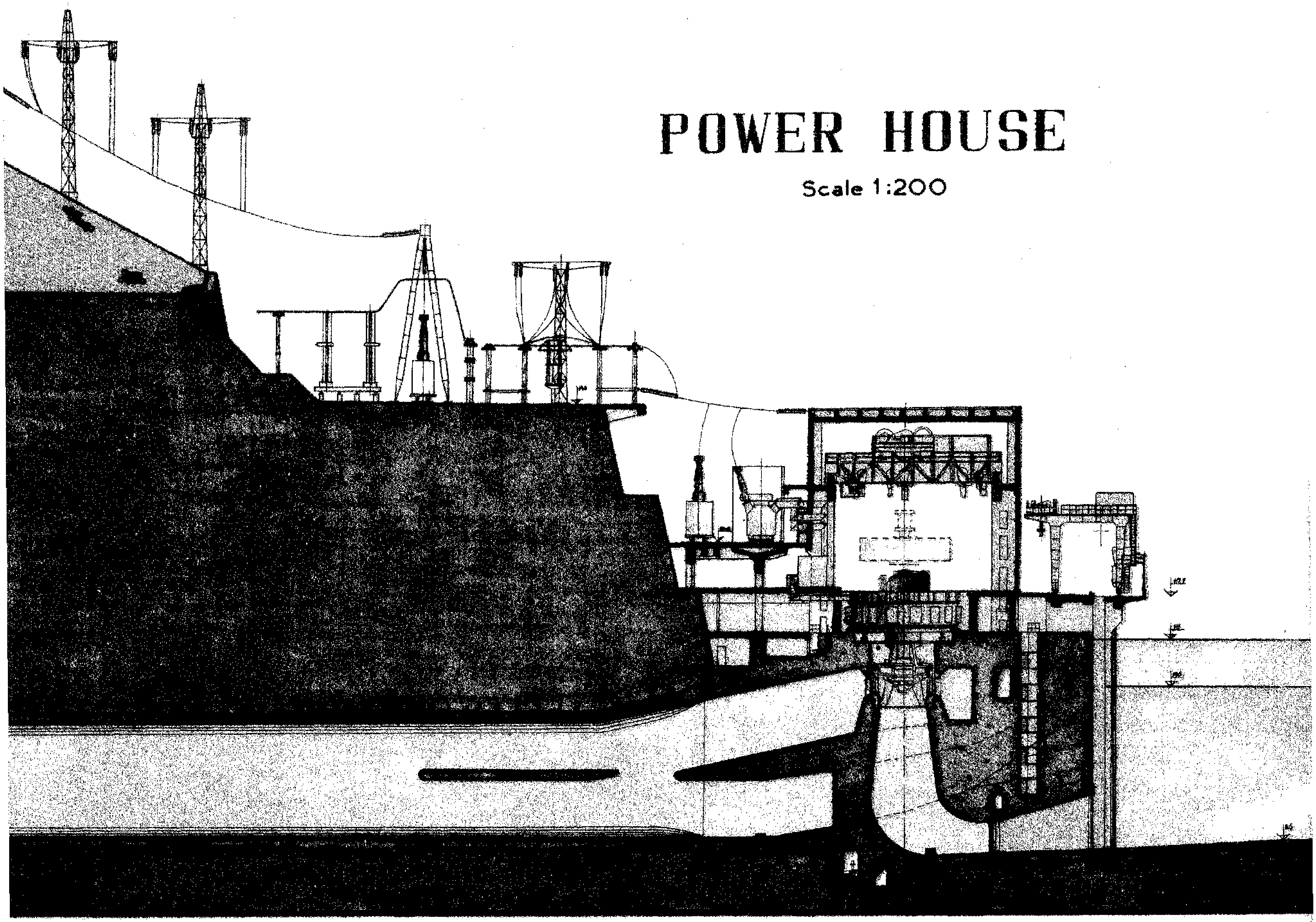
Hydro Power Station



Hydro Power Station

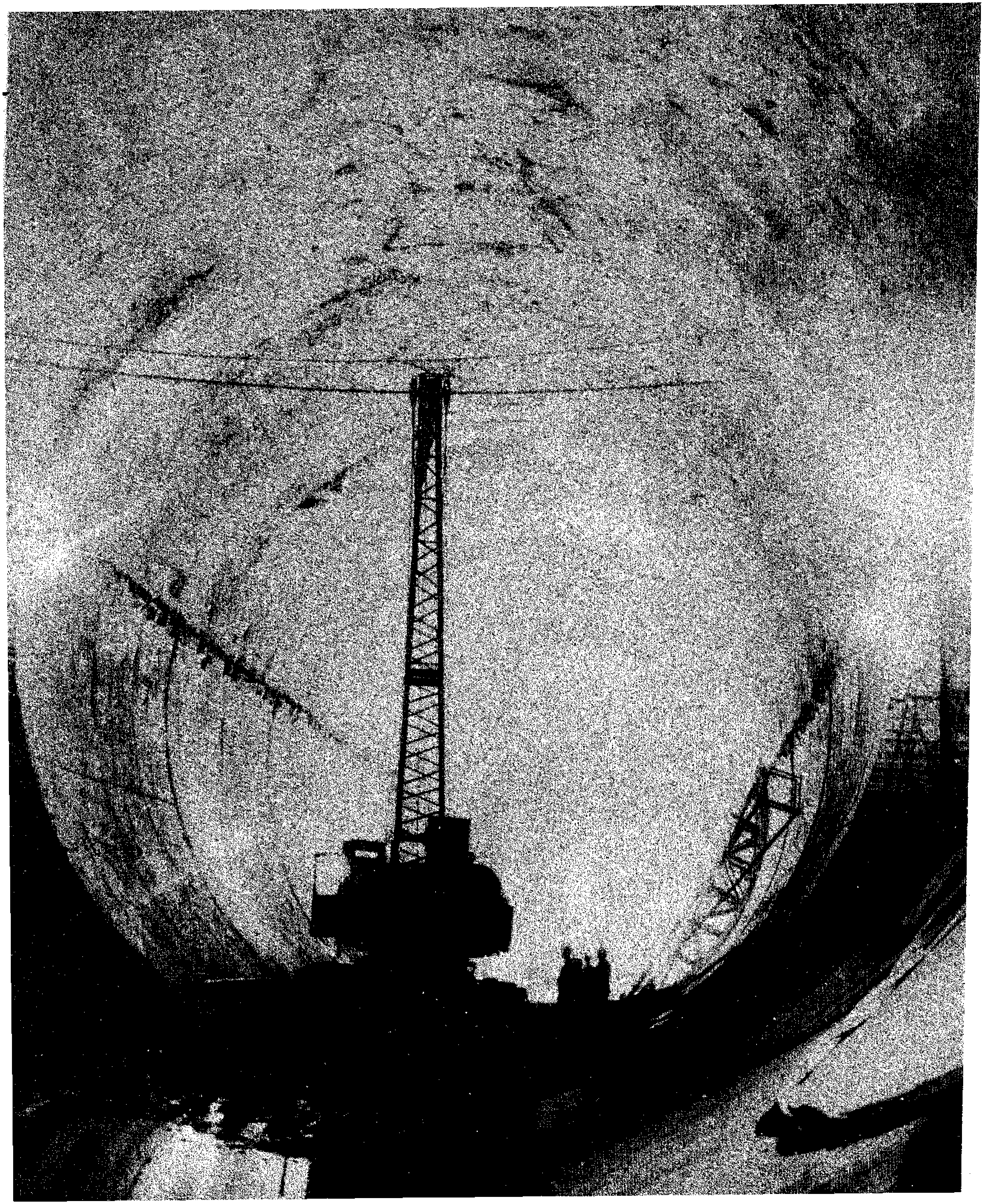
# POWER HOUSE

Scale 1:200

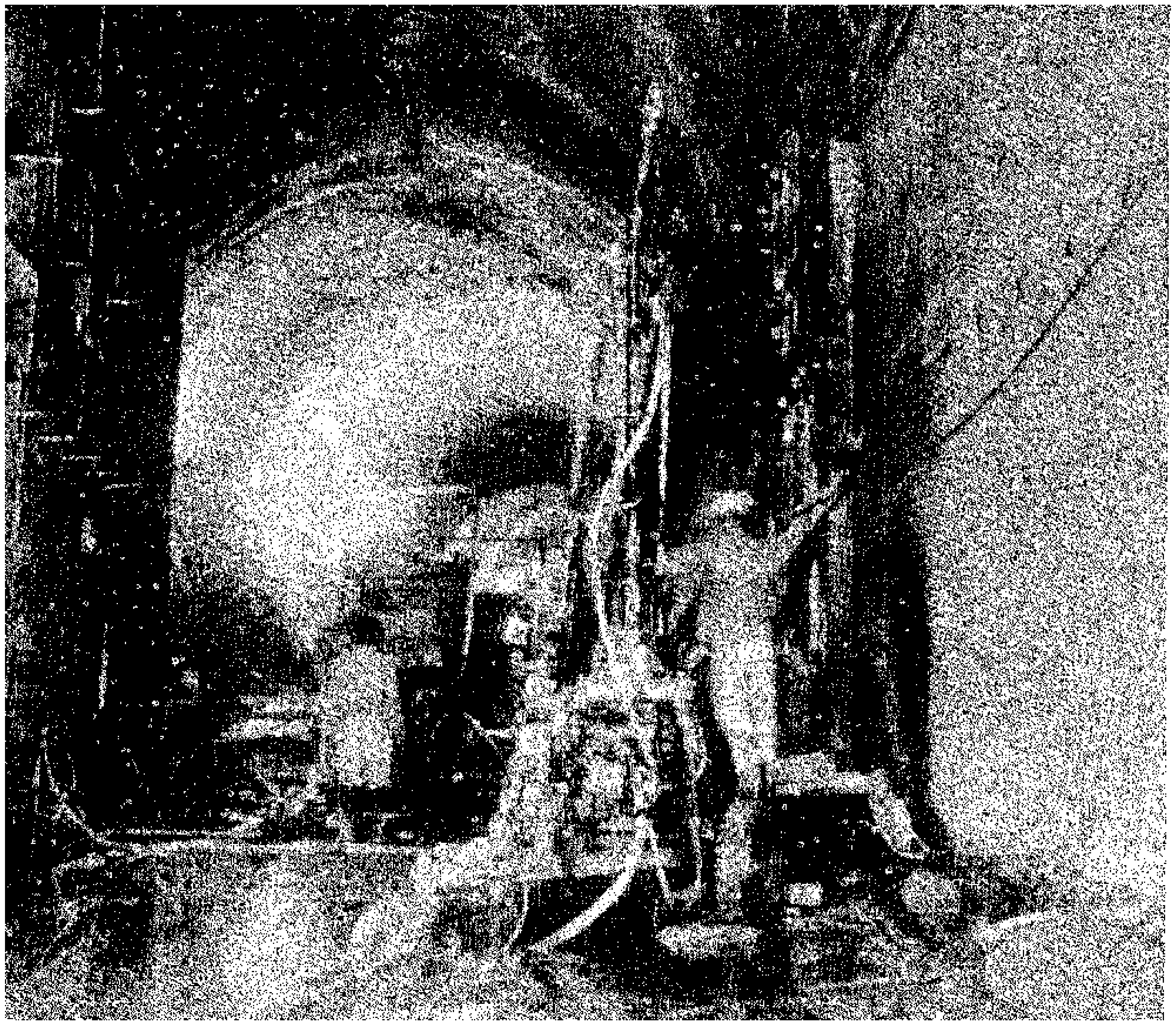


Excavation of lower bench of tunnel

Drilling of lower bench of tunnel

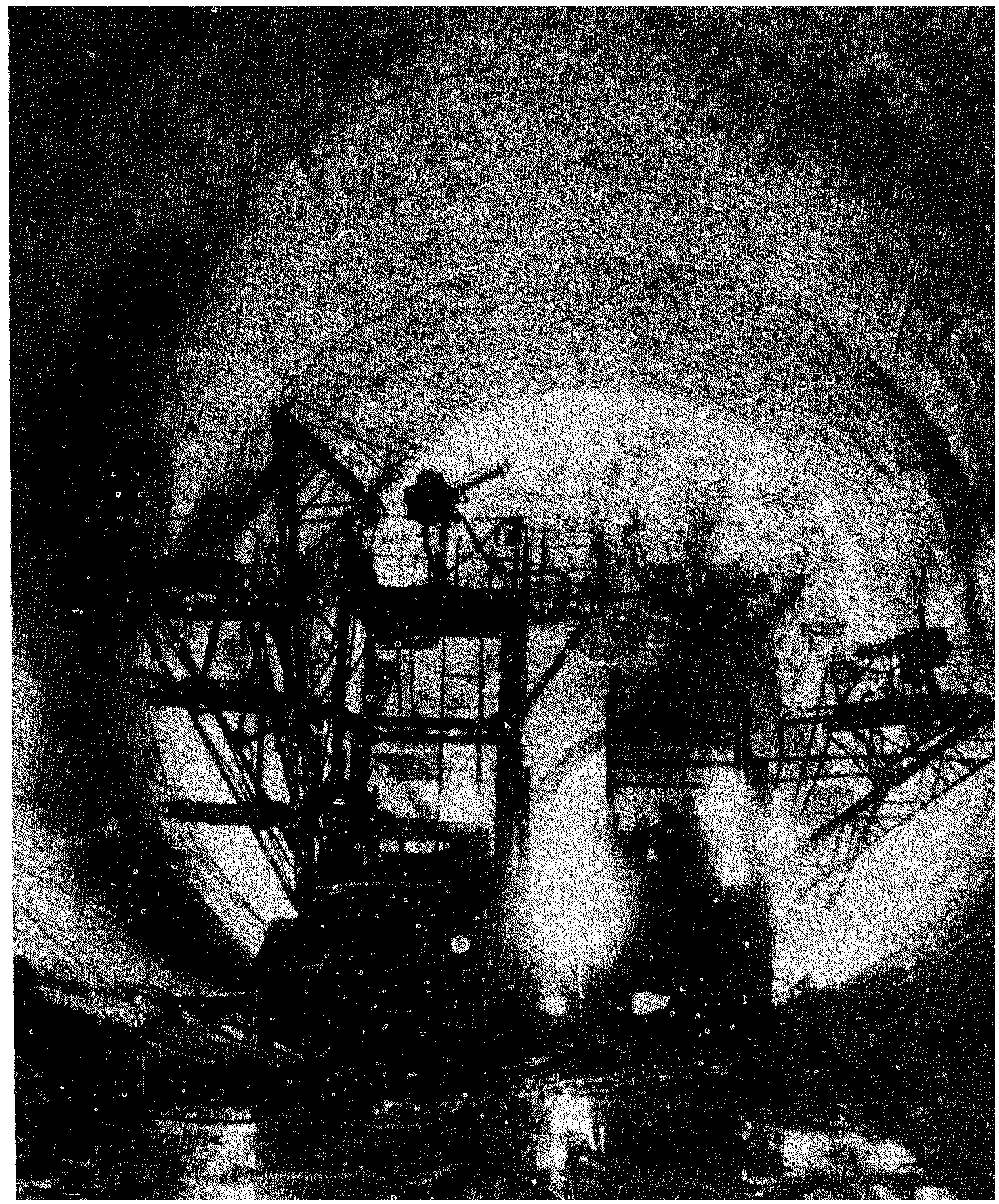


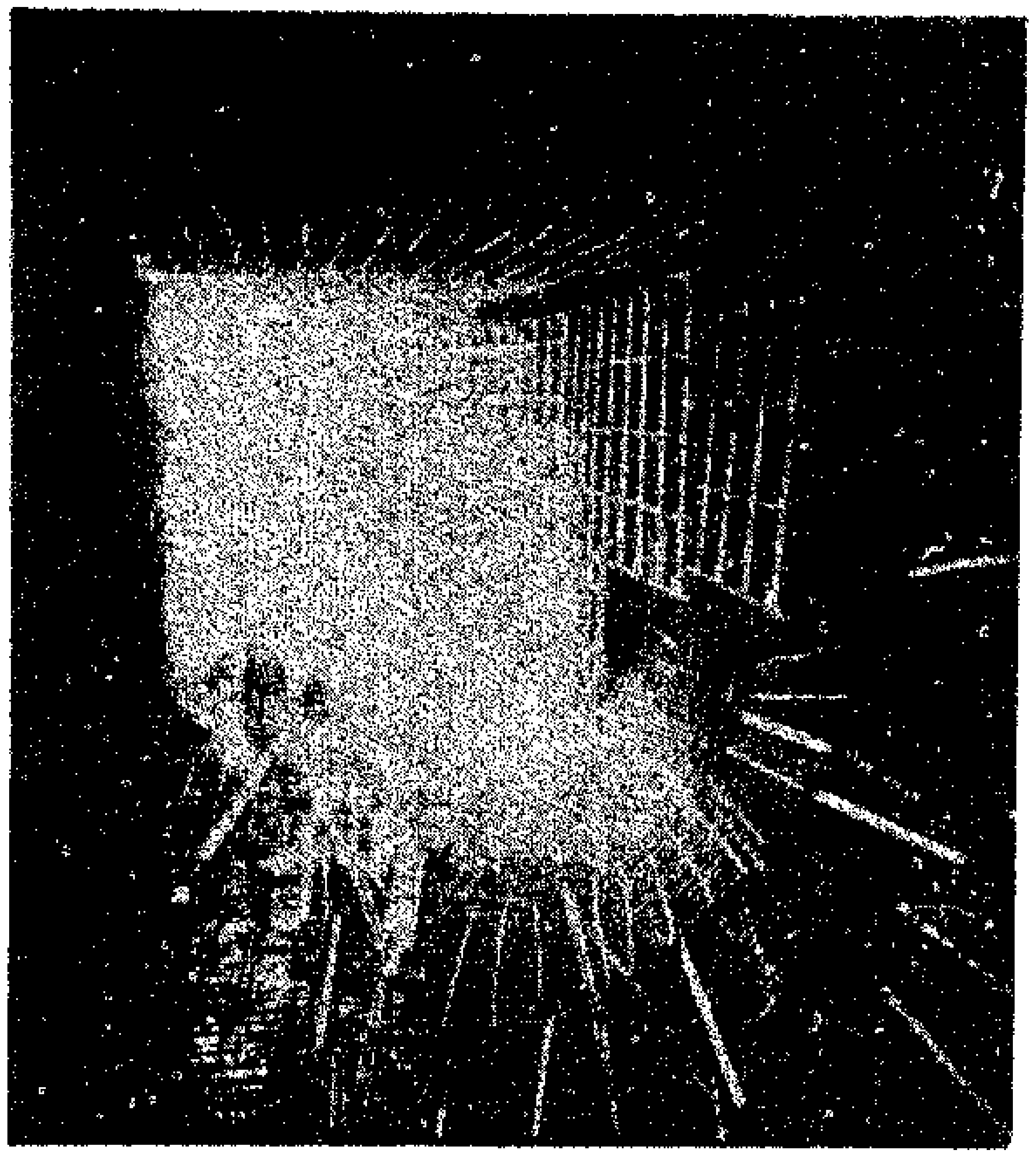
Part of the main tunnel after its completion and casting the concrete lining.



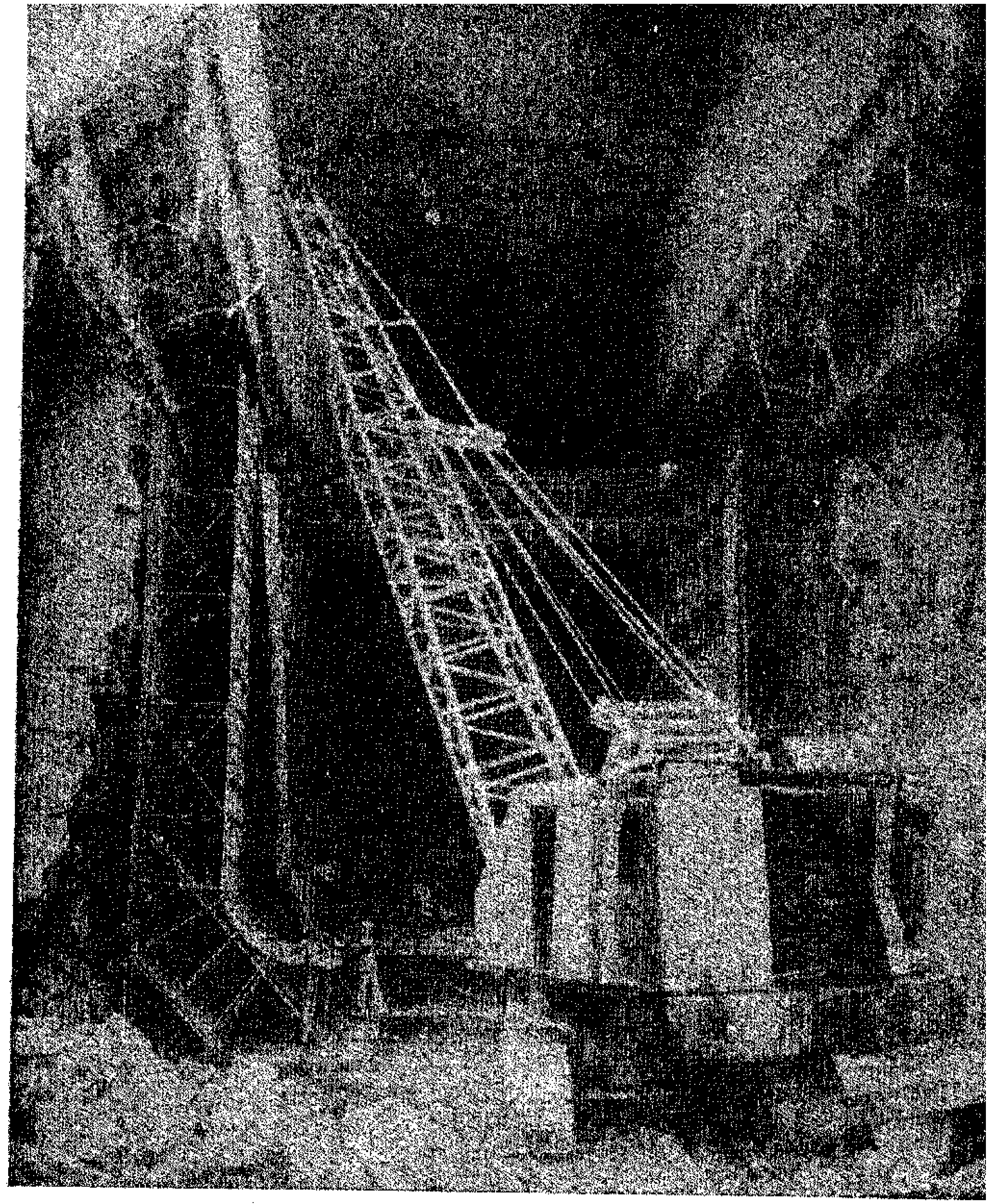
Injection operations
in tunnel inlet.

Injection operations
in main tunnels.

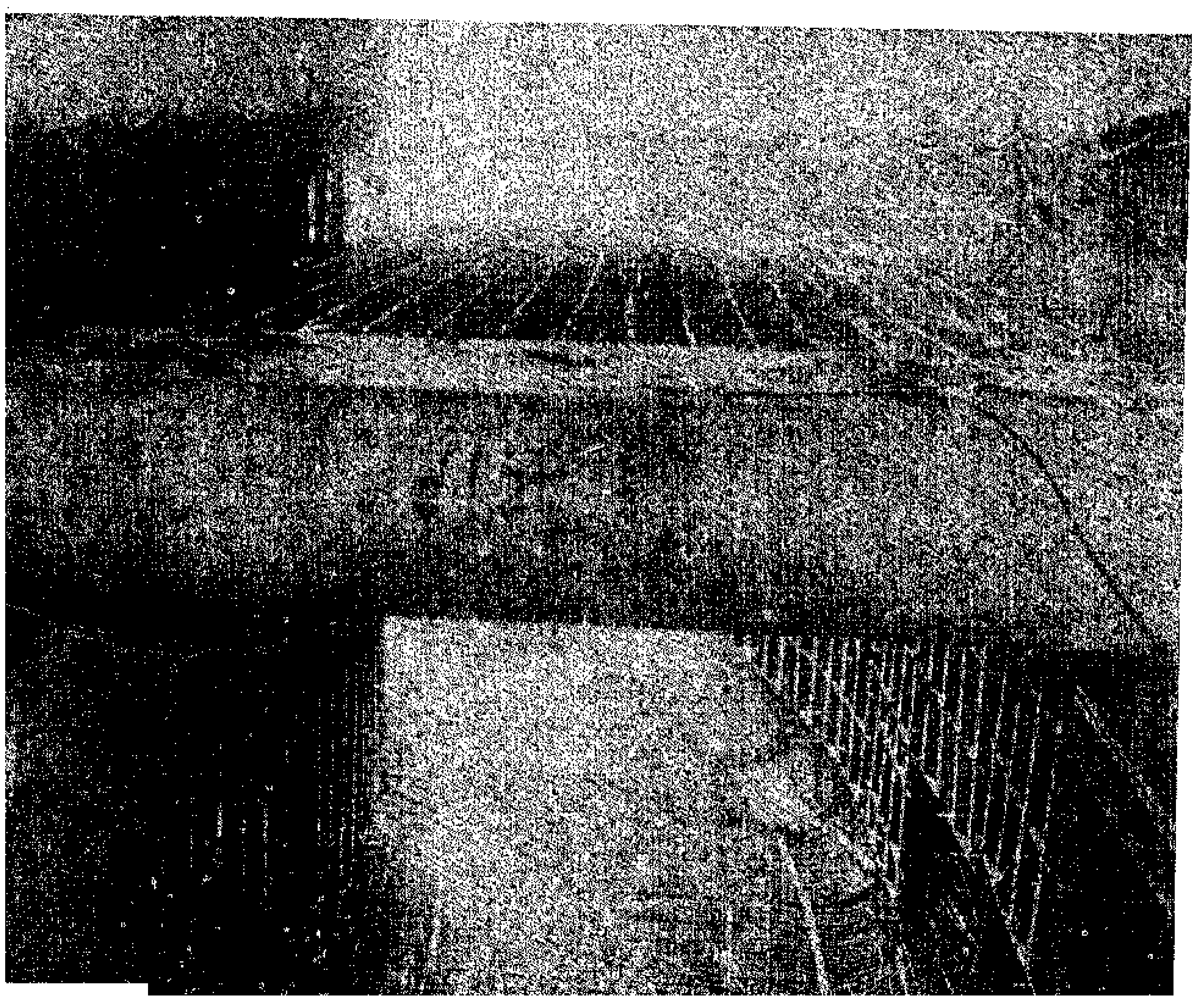




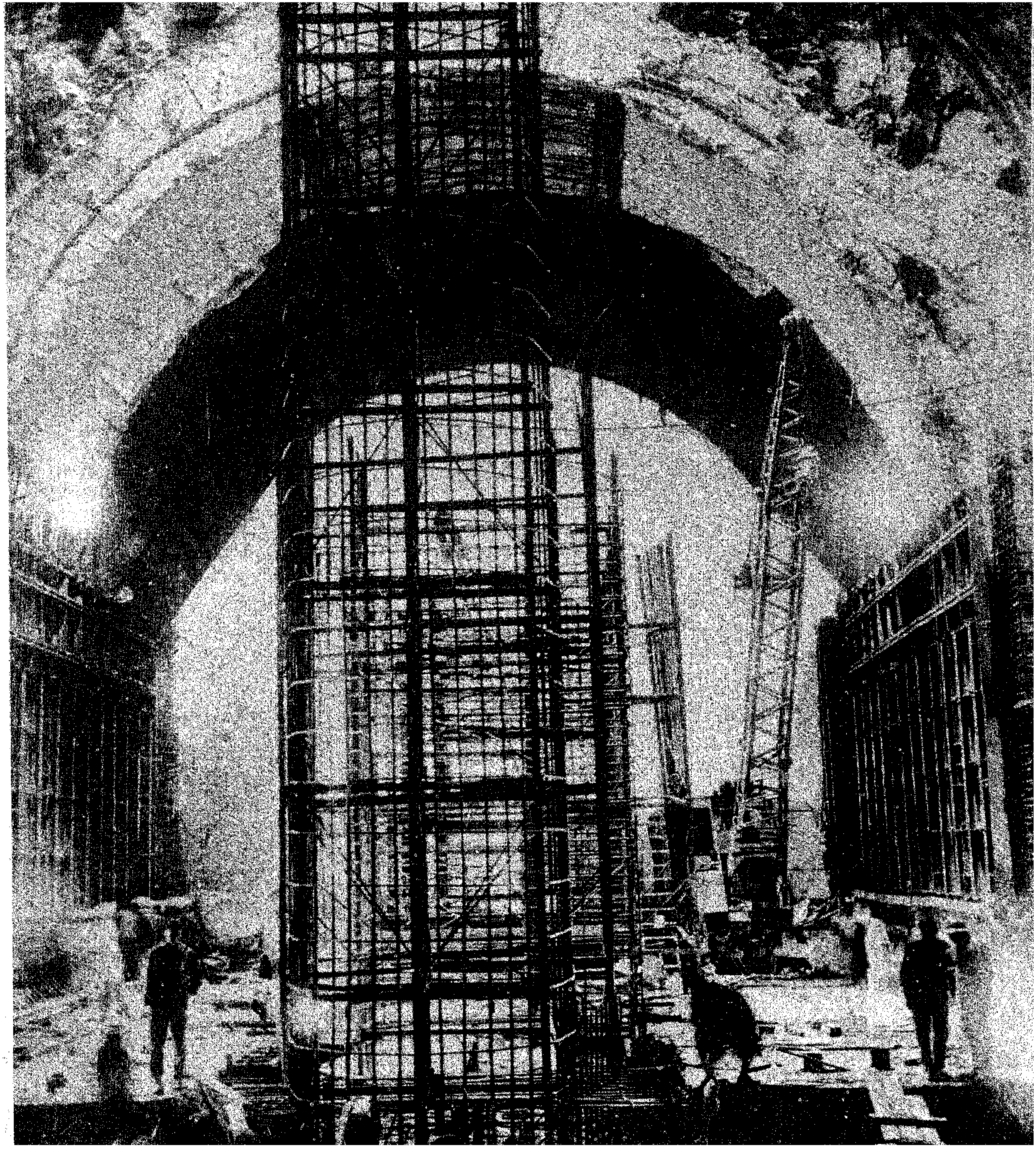
Placing of reinforced wooden shuttering after erection of steel reinforcement in the left branches.



Erection of steel reinforcement in lower bench of tunnel branches.

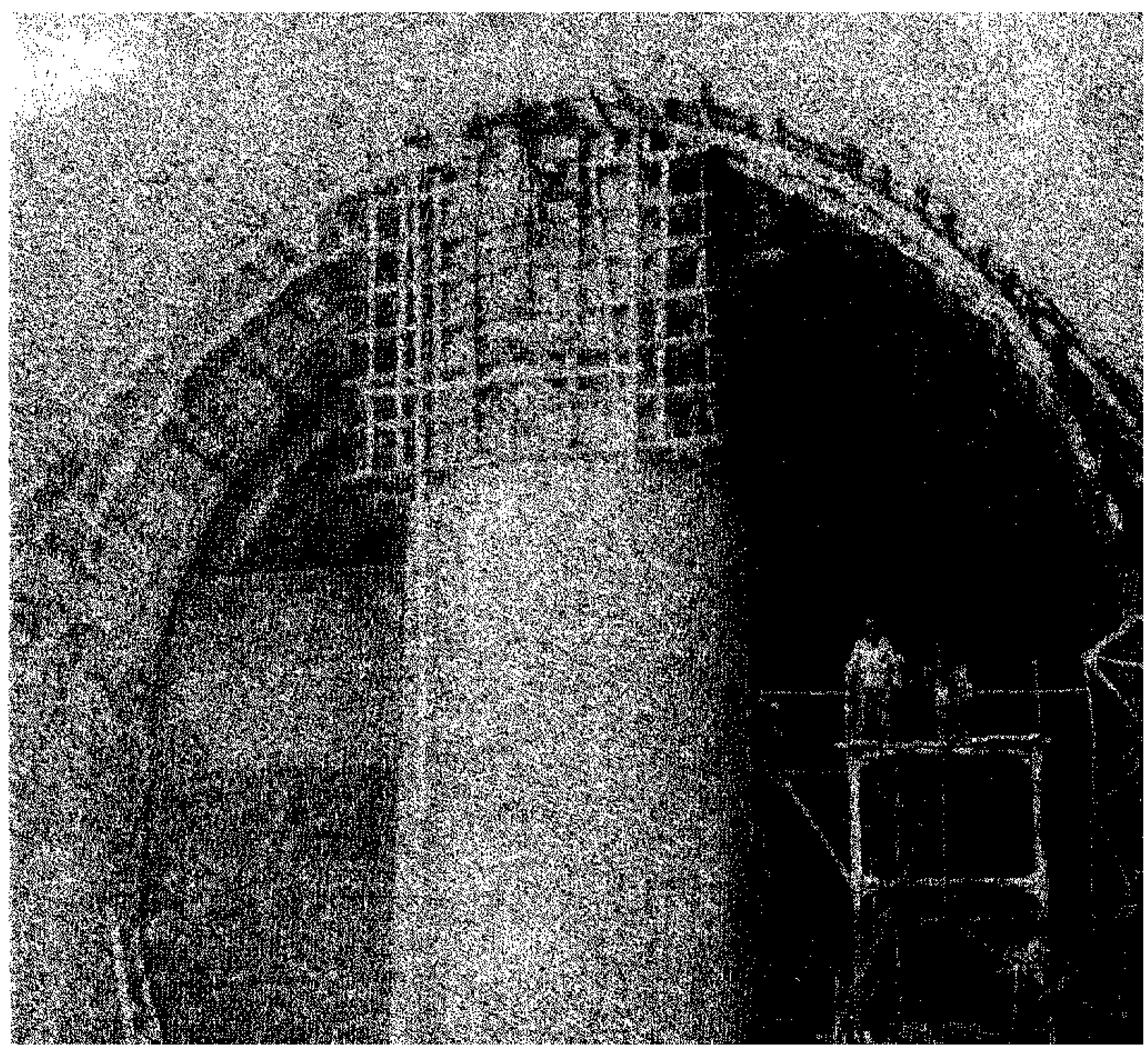


Erection of steel reinforcement, steel lining and shuttering in the lower bench of left branches (view from main tunnel).



Erection of reinforcement steel of the mid pier at tunnel inlet

Tunnel inlet. View from interior of tunnnel



Tunnel inlet during erection of gates

## CONSTRUCTION OF THE DAM BODY

The High Dam body (as shown in the attached cross-section) consists of a series of prizms of rock muck, screened stones, dune sand and coarse sand. These sections are so arranged together with the central clay core, horizontal blanket and vertical grout curtain according to the agreed upon profile ensuring its stability and complete safety. Self discharging barges were used to dump the rock in their corresponding prizms. Rock over 15 cm was obtained by specially designed screening plants. Dune sand was obtained from the western side of the river and transported by the hydromechanization method (which will be explained later) to their stock or to be dumped directly in the river. Dune sand was sluiced in the Nile at layers 15 m thick and then compacted by specially designed vibration plants which were brought from the Soviet Union for this purpose. Coarse sand was brought from a sand quarry some 11 km from the dam site, by railway wagons to a dump area, and then passed through classifiers where they are washed from fines before being sluiced into the river.

The banks of the Nile at the dam site were carefully cleaned, loose rocks were removed, washed then grouted with cement gun to fill all the fissures and cracks in the rock.

Work in the dam body started on the 9 January 1963 when President Gamal Abdel Nasser threw the first granite stone. Up till the 10th of May, 1964; 4,166,000 cu.m. of stones were dumped in the river with a maximum daily rate of 30,600 cu.m., the highest monthly volume was 611,400 cu.m. in January, 1964, 5,937,000 cu.m. of sand were sluiced in the river; the highest monthly volume was 1,045,000 cu.m. in January 1964 with a maximum daily rate of 44,000 cu.m.

A gap 120 m wide was left in the western side of the river channel for water flow and river transportation. By closing this gap the river flow will be diverted completely through the canal and tunnels.

As previously mentioned, this part of the dam body is enough for the Nile diversion and the work of the first stage of the dam will continue till November 1964 when it reaches a height of 47.5 m above the Nile bed.

# HYDROMECHANIZATION

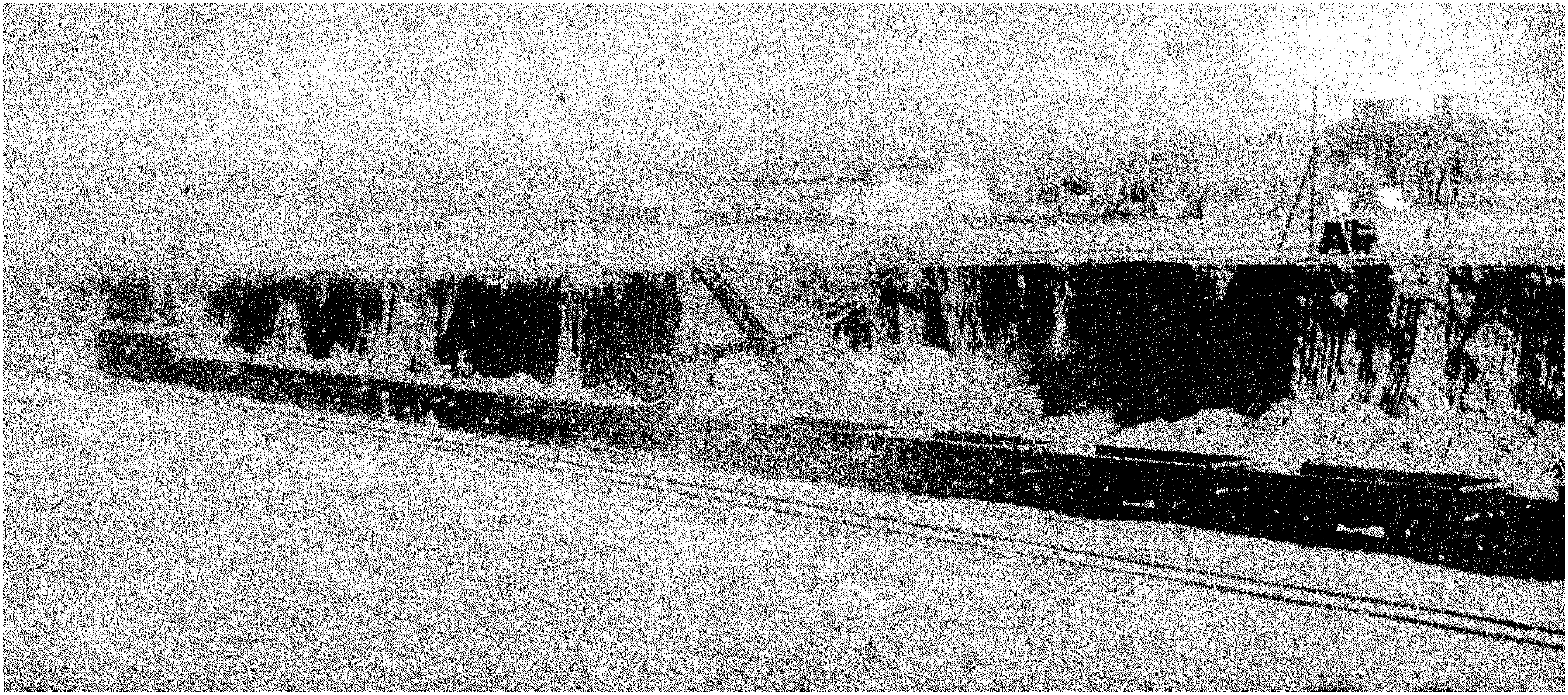
The hydromechanisation process is simply the suspension of loose materials in water by means of water jets and then transferring the suspended mixture through pipelines by pumping.

Hydromechanization was successfully used in quarrying and transporting the sand required for the construction of the High Dam body and cofferdams. In order to cope with the high rates of sand sluicing it was necessary to build a huge stock of sand on the western bank.

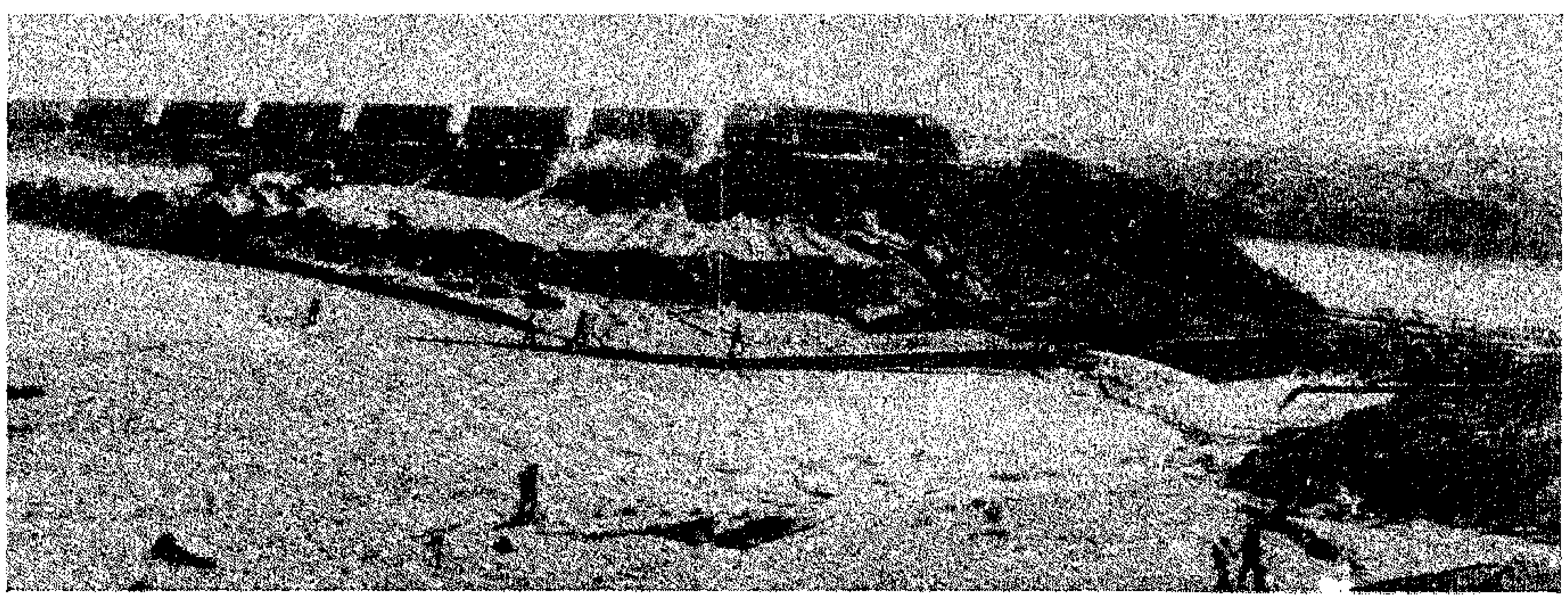
Furthermore, hydromechanization was used in the removal of the old temporary upstream cofferdam.

The total volume of sand transferred till the 15 May, 1964 was 12.2 million cu.m., the highest monthly volume was 1,045,000 cu.m. in January 1964 and the maximum daily rate was 44,000 cu.m.

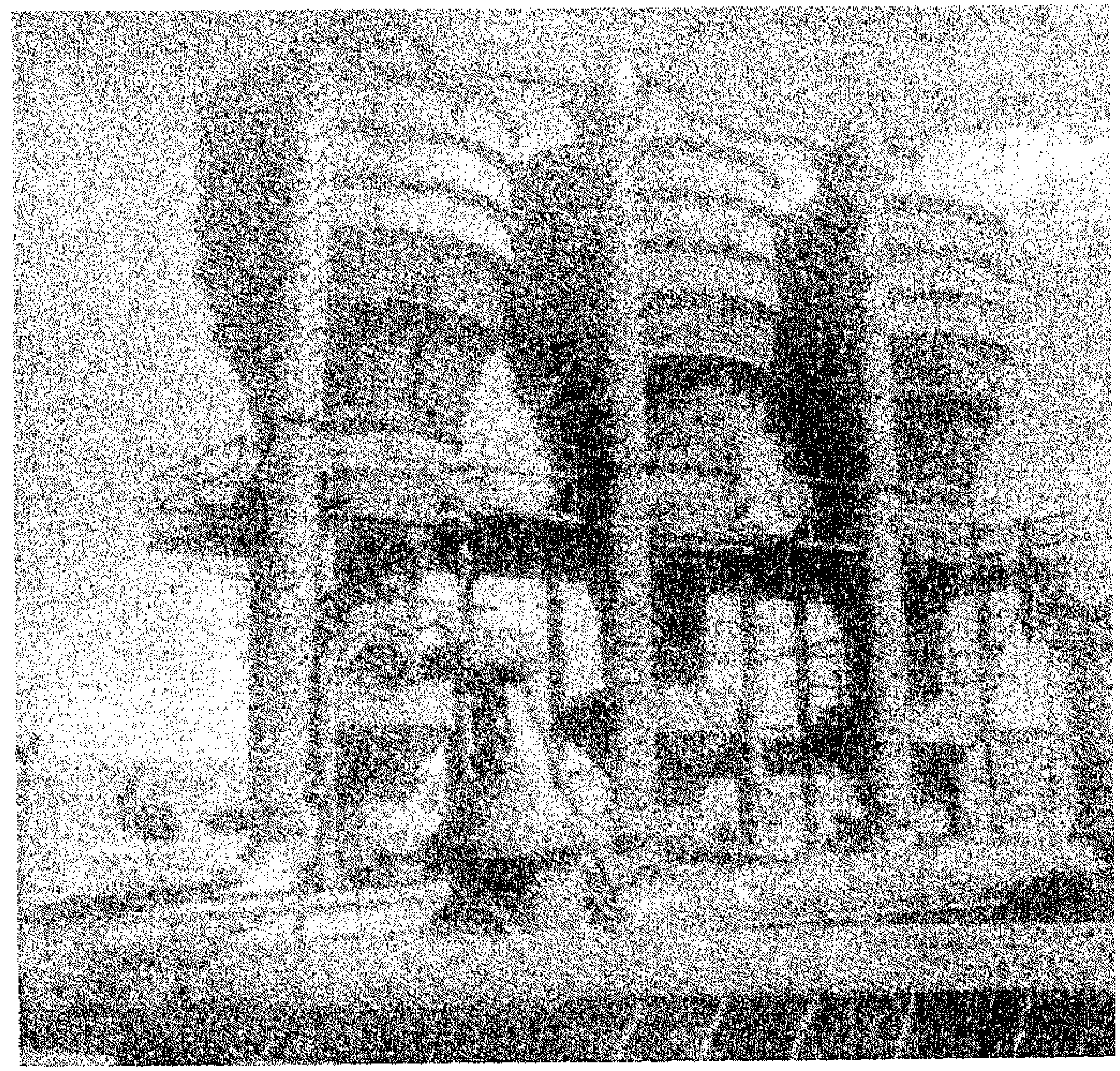
General view of a dune sand quarry, showing hydro moniters during operation.



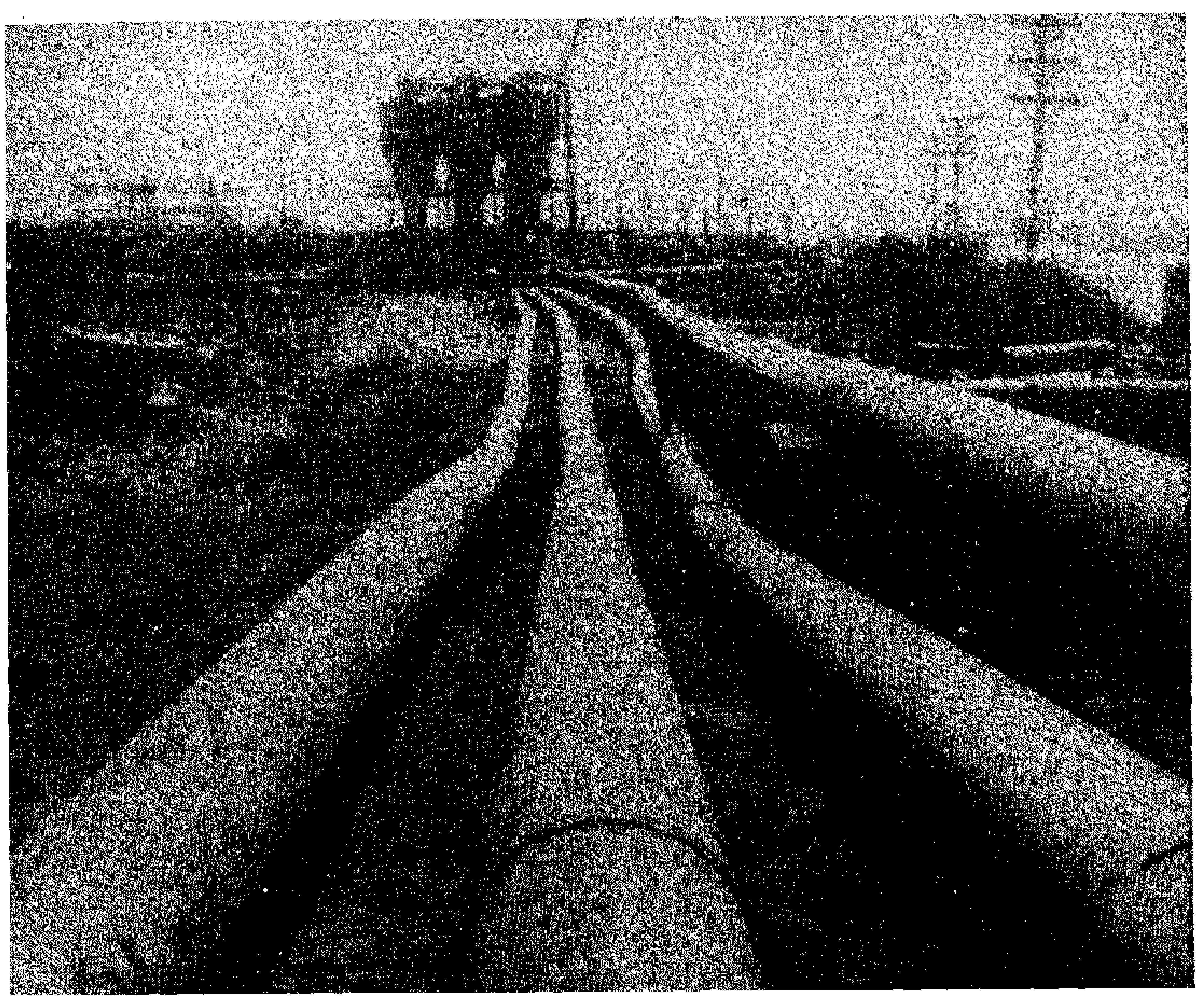
Coarse sand quarry at Shellal during loading railway wagons.



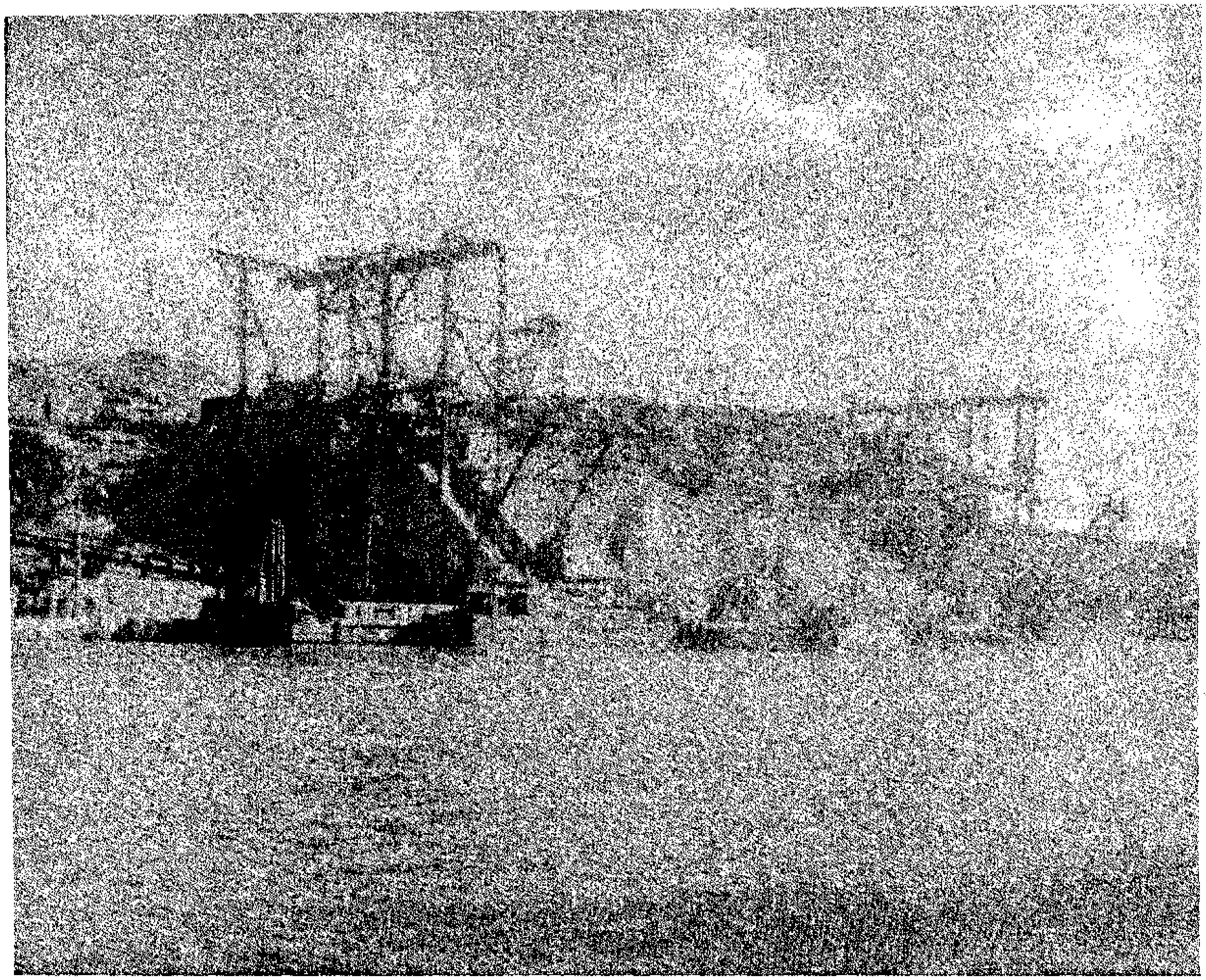
A railway train unloading coarse sand at dump area, hydro moniters and sand pumps shown.



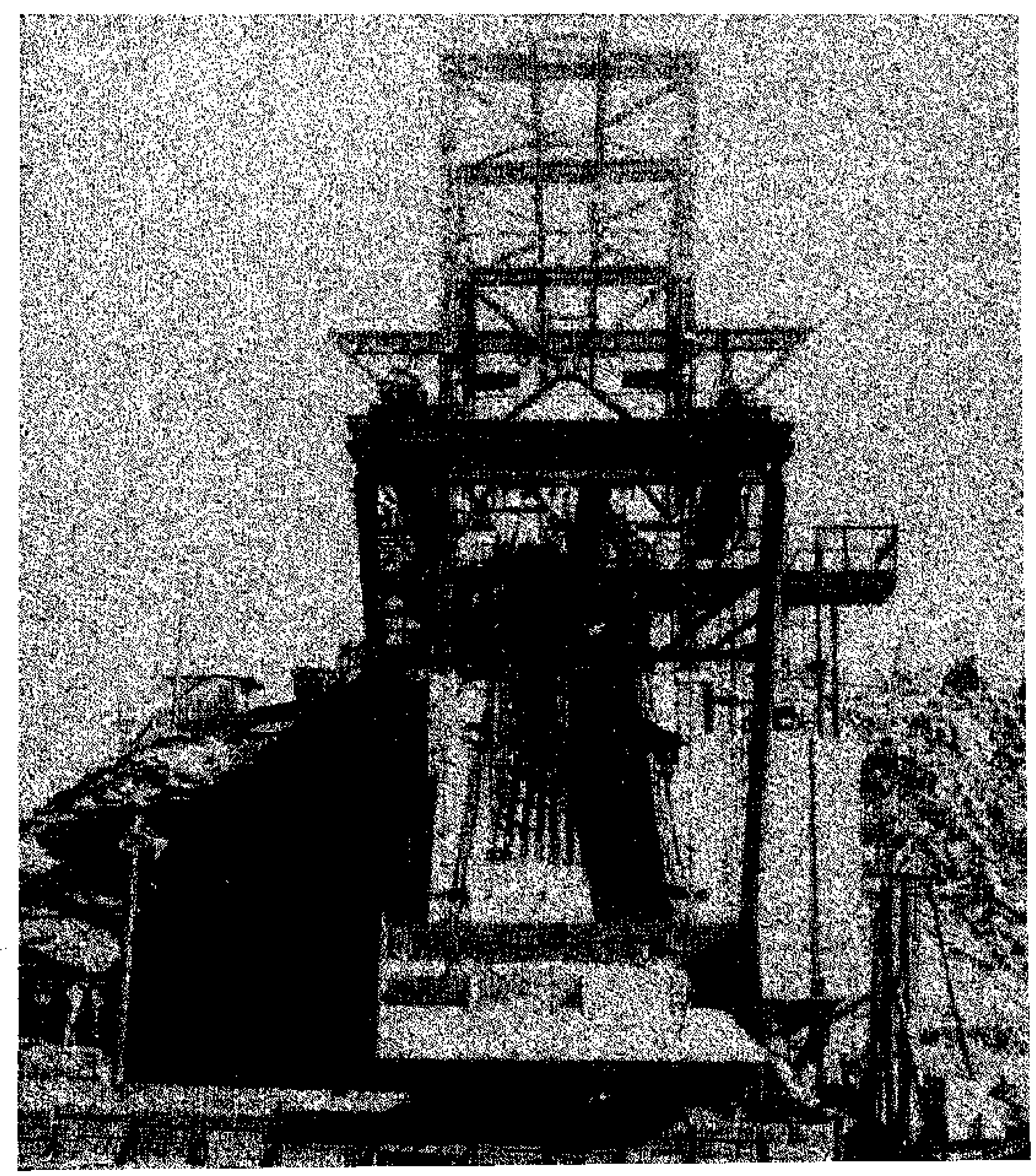
Coarse sand classifiers.



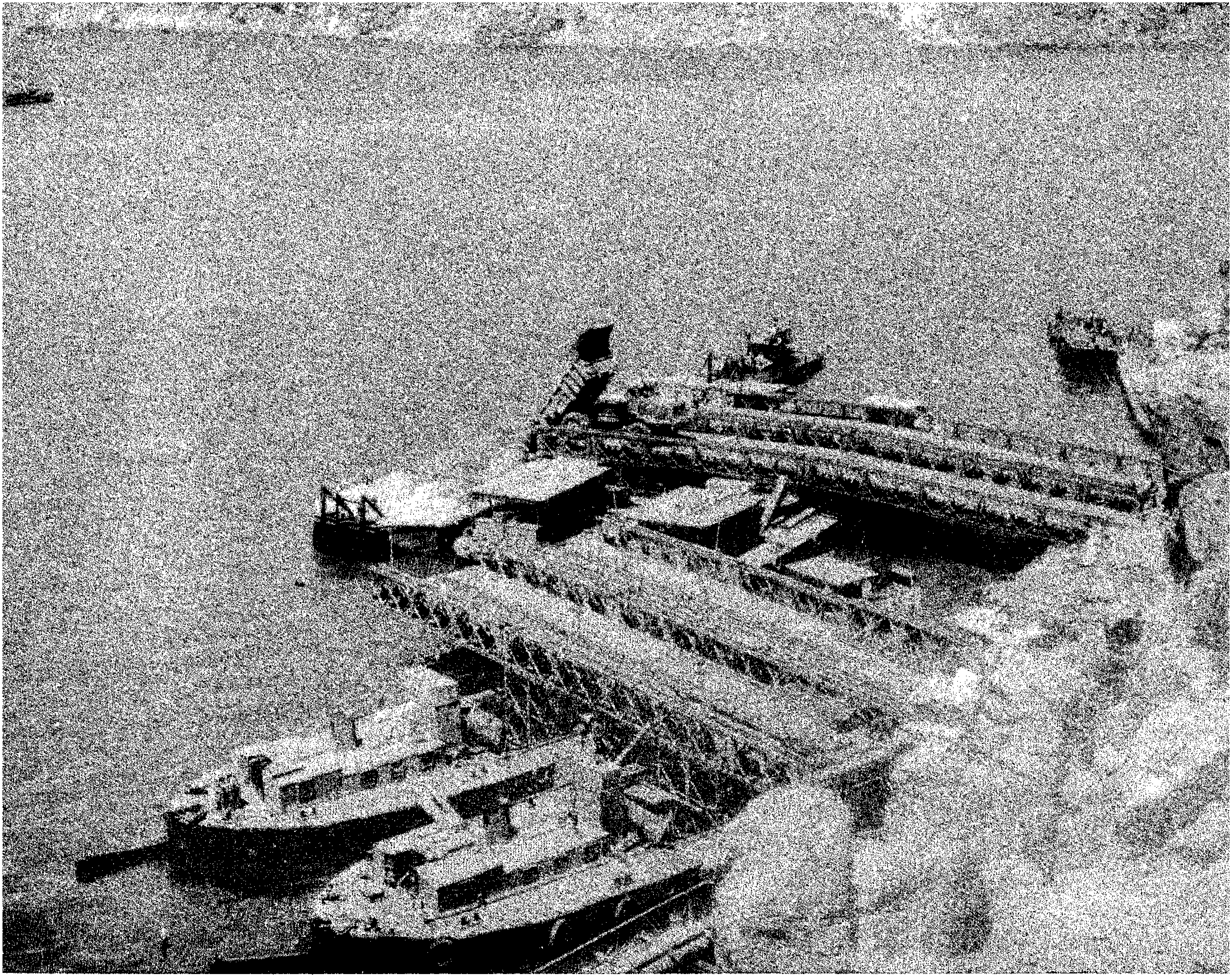
Hydromechanisation pipelines leading to classifiers.



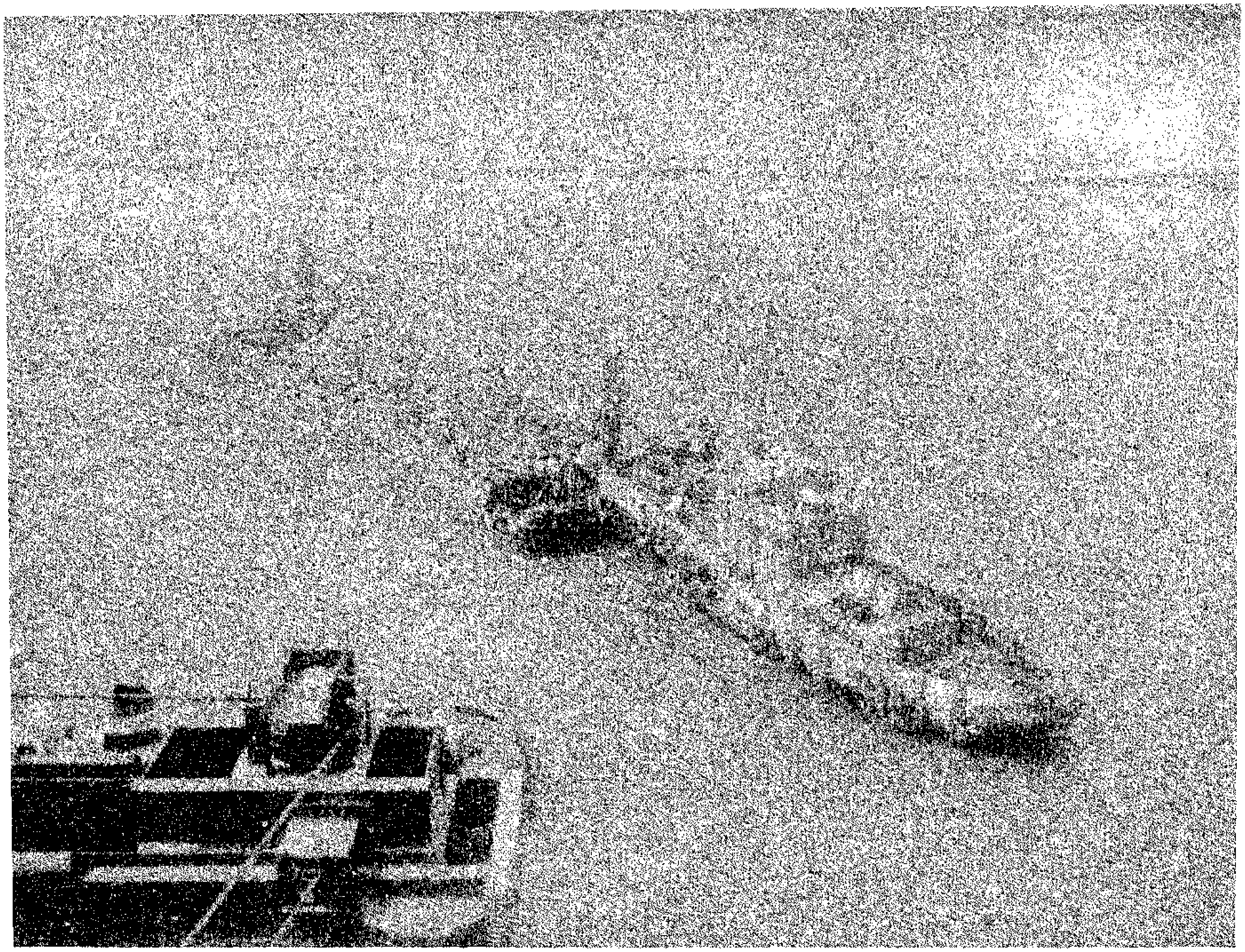
Stone grading plant No. 1 at D.S. berth



Loading of 250 ton barge from the screening plant at D.S. berth.

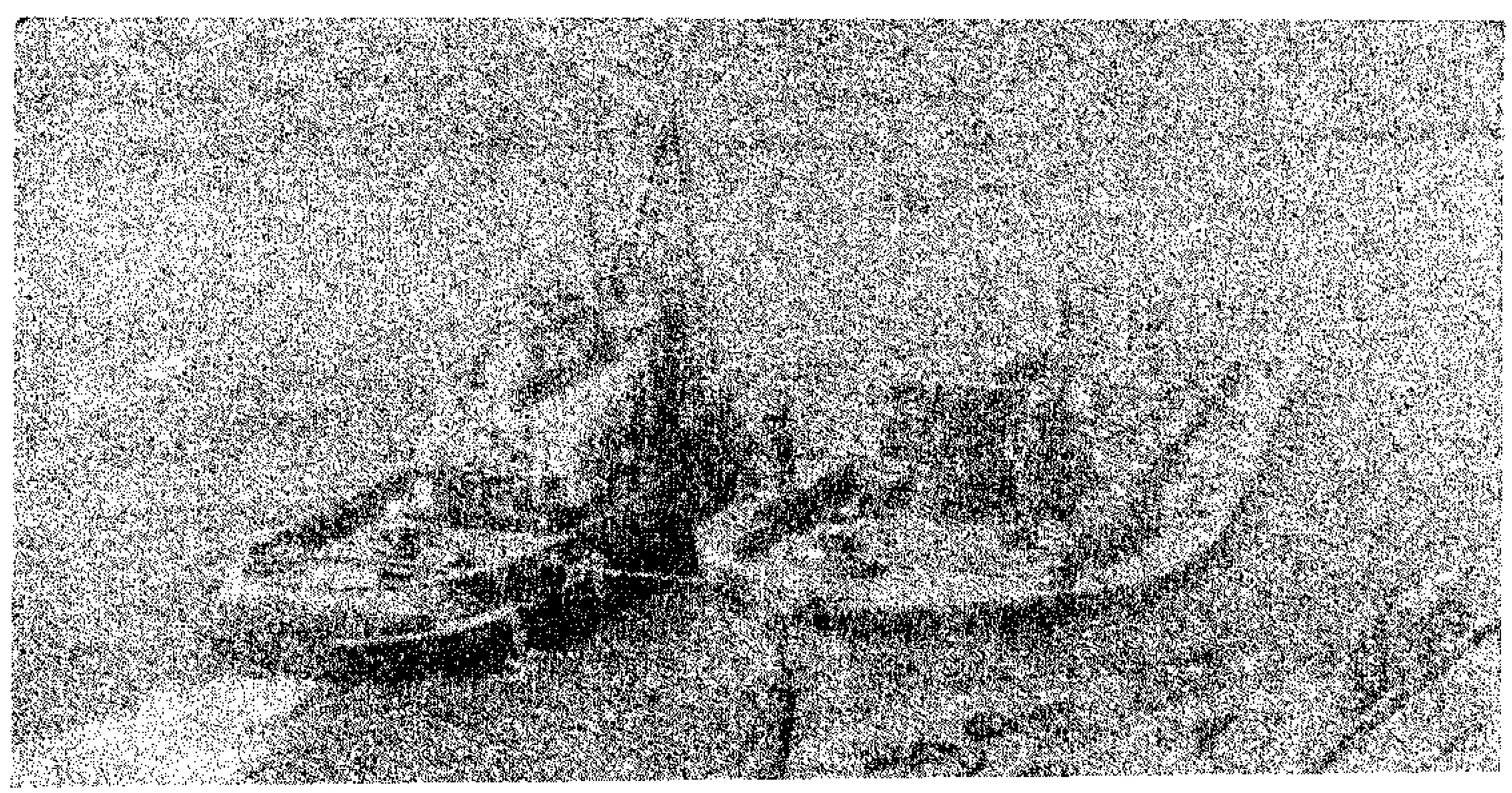


Loading of barges from the floating bridge.

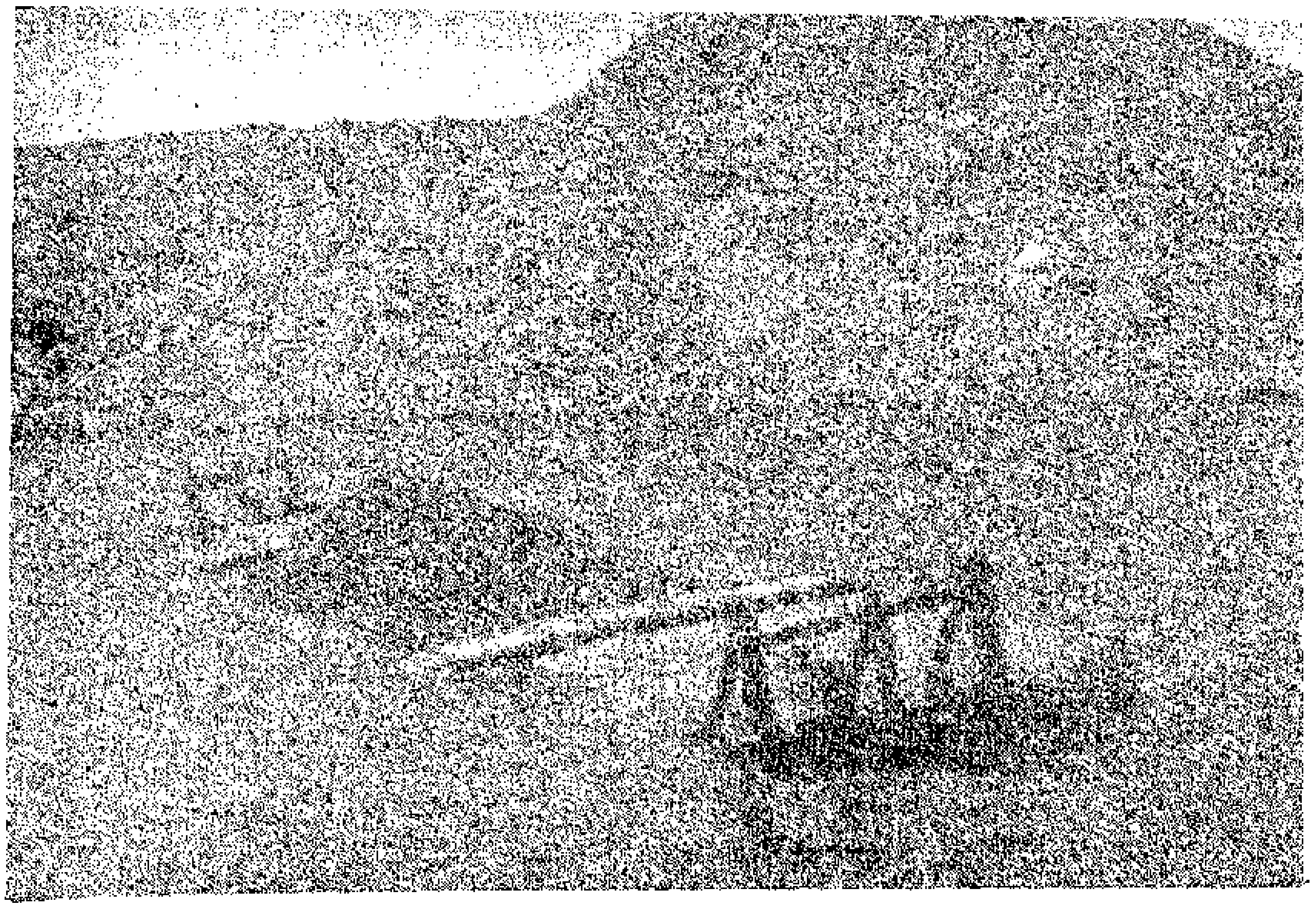


250 ton barge loaded with screened stones in its way to dumping site.

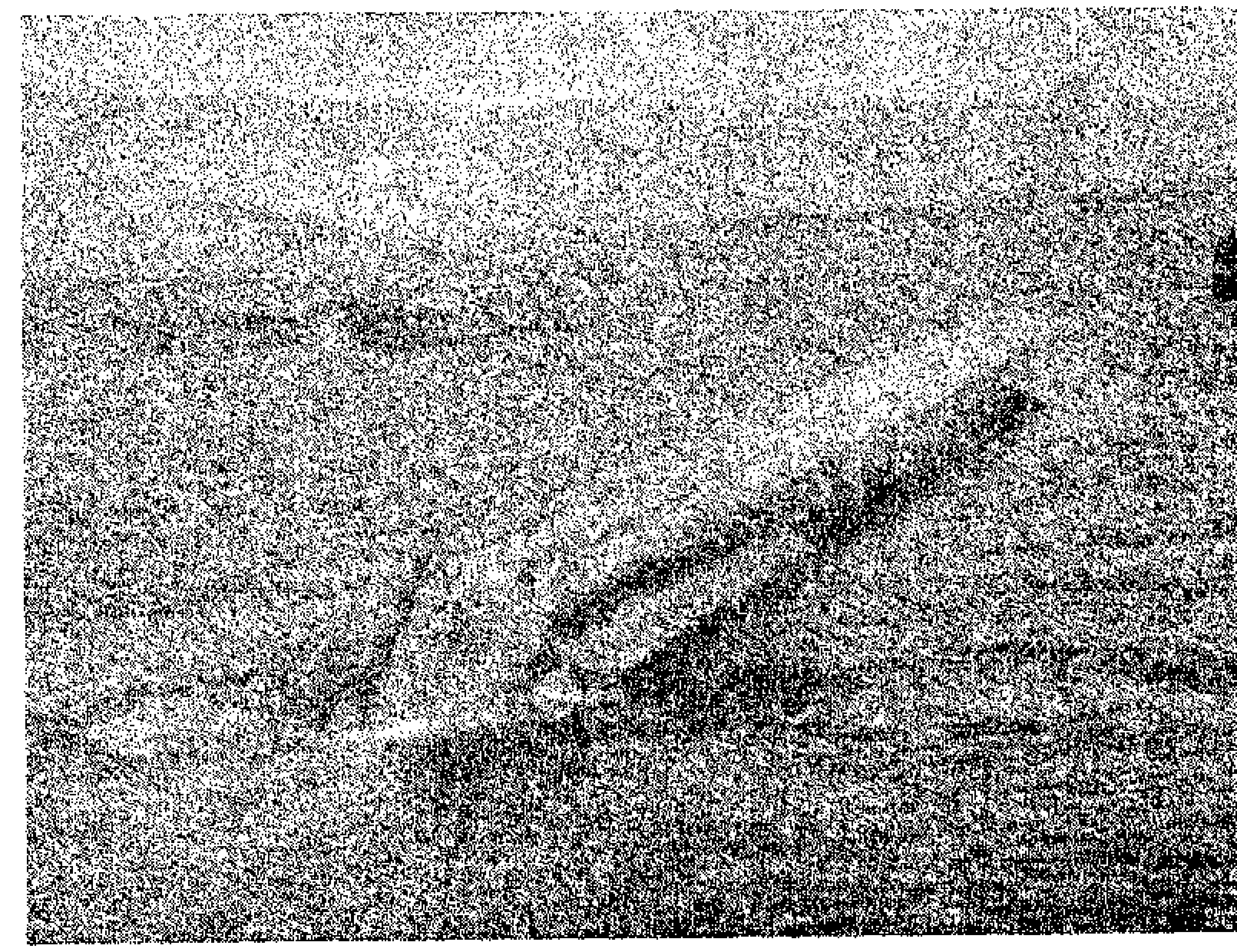
250 ton barge leaving the D. S. berth after loading.



500 ton self unloading barge

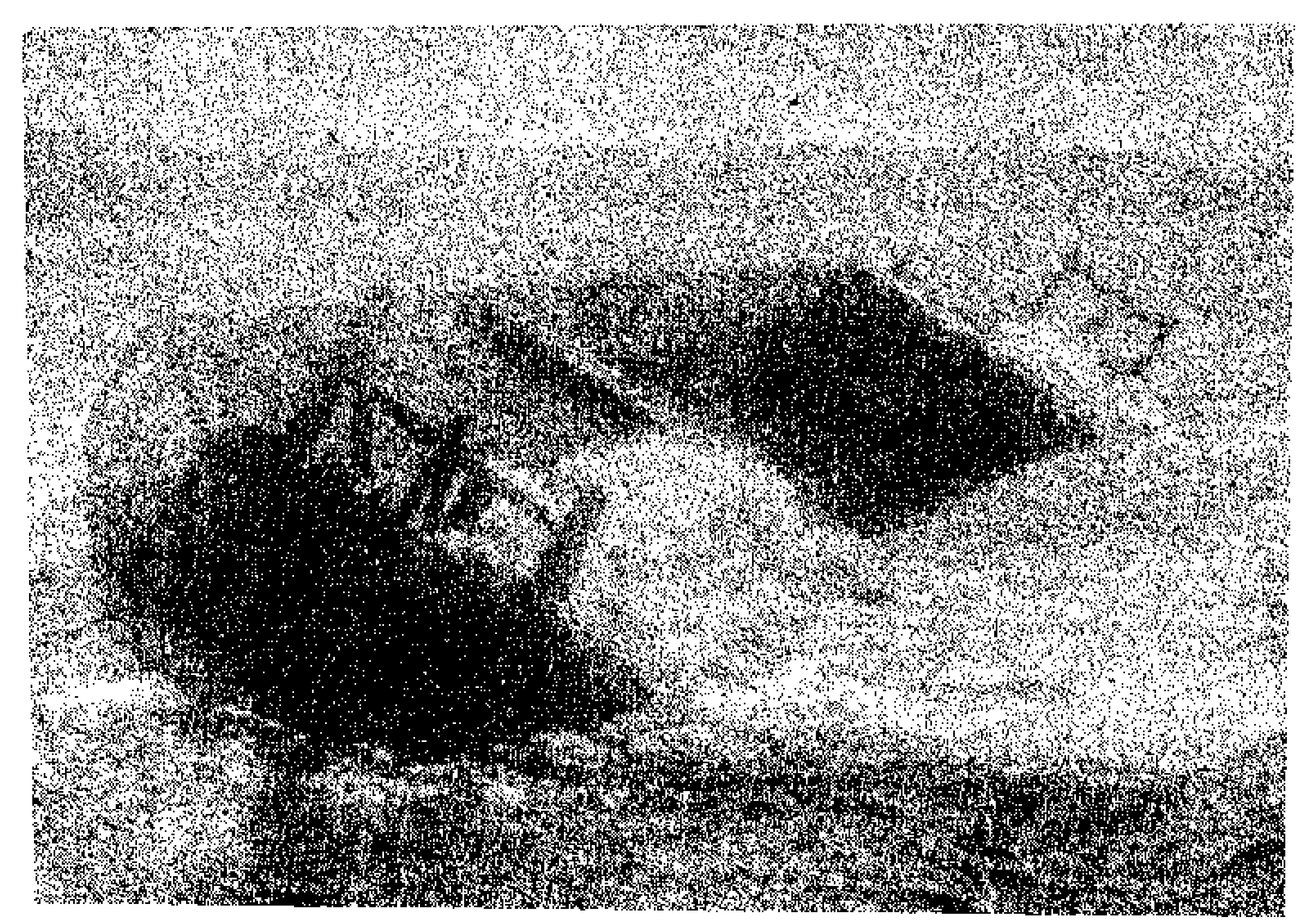


Barge at dumping site

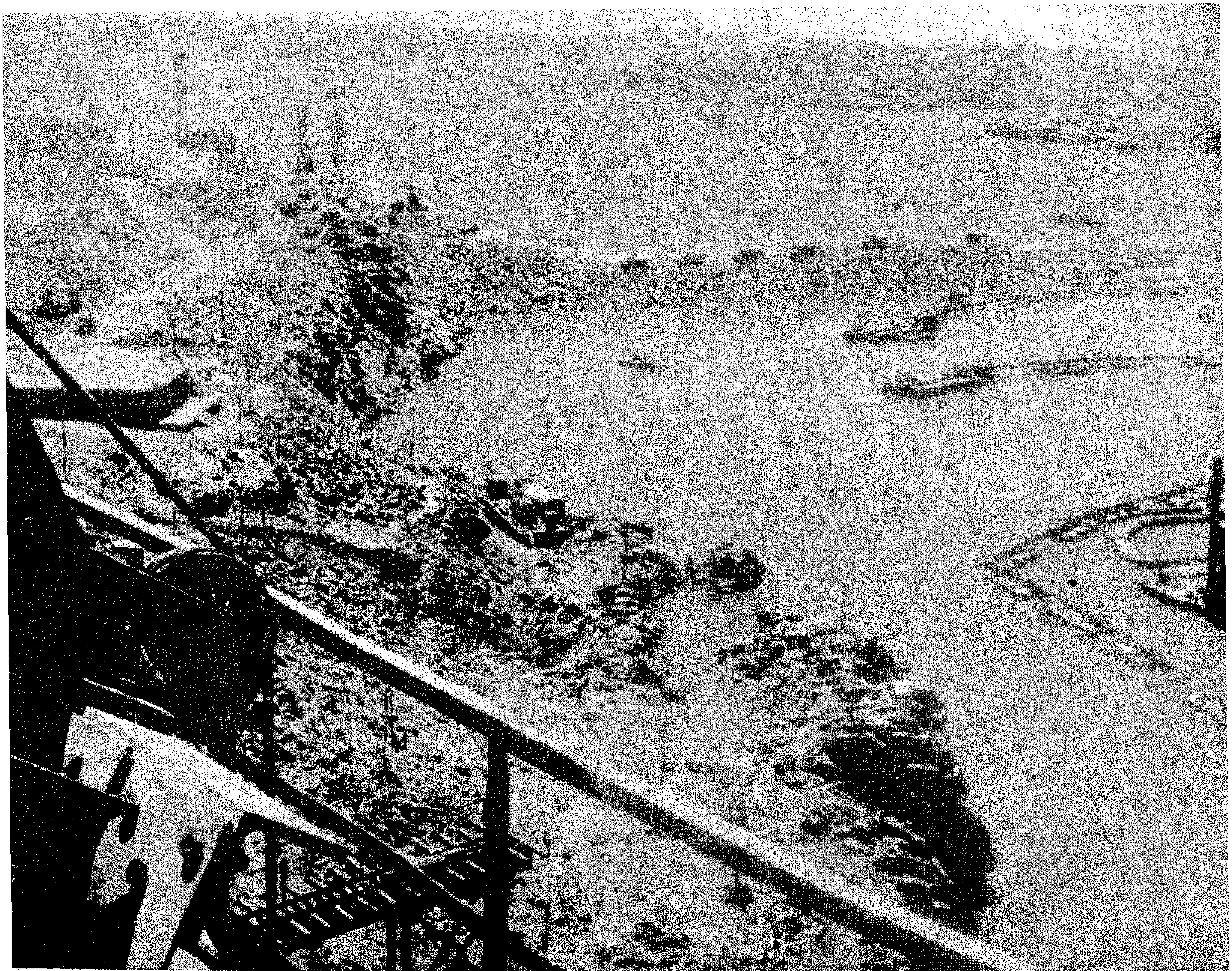


Starting of stone unloading

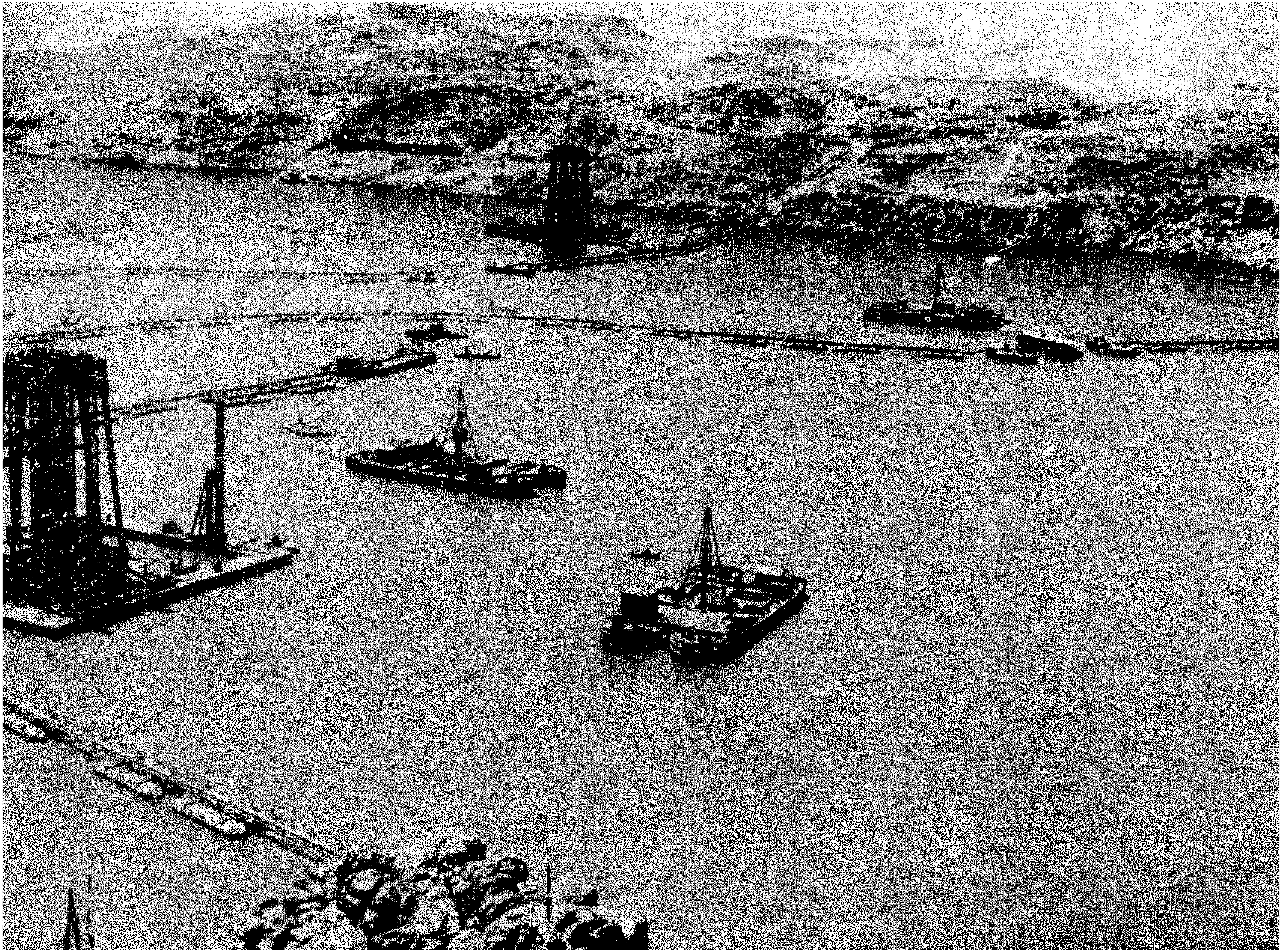
Barge turned upside down



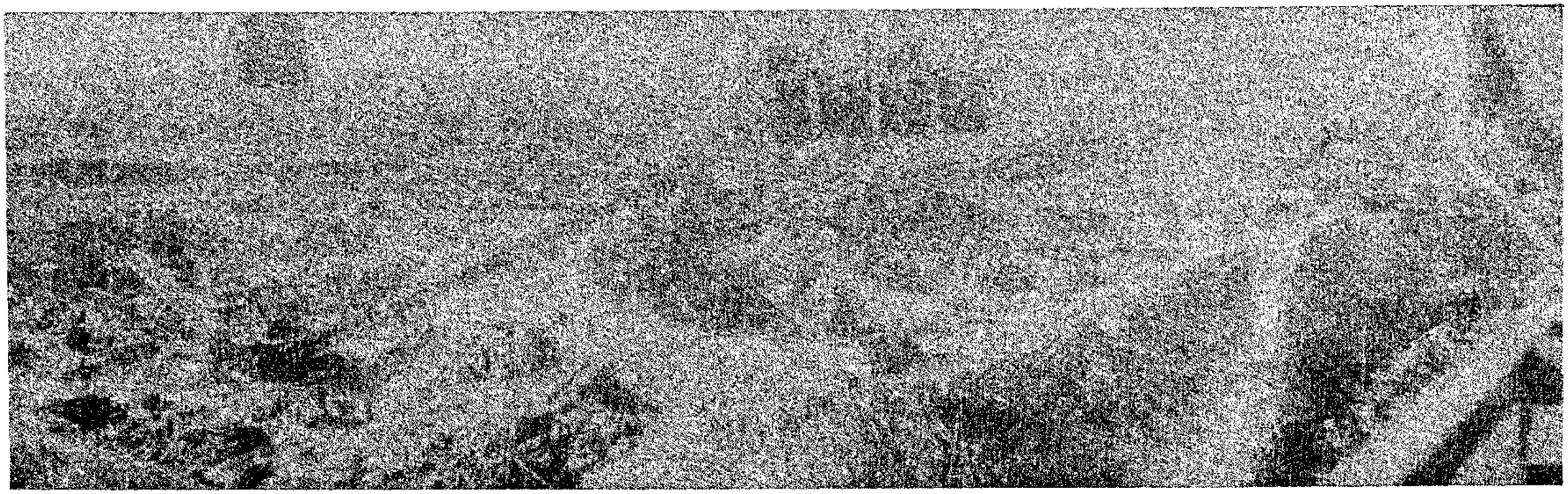
Barge returning to normal position after unloading



Execution of the body of Dam in 31. 3. 1964.

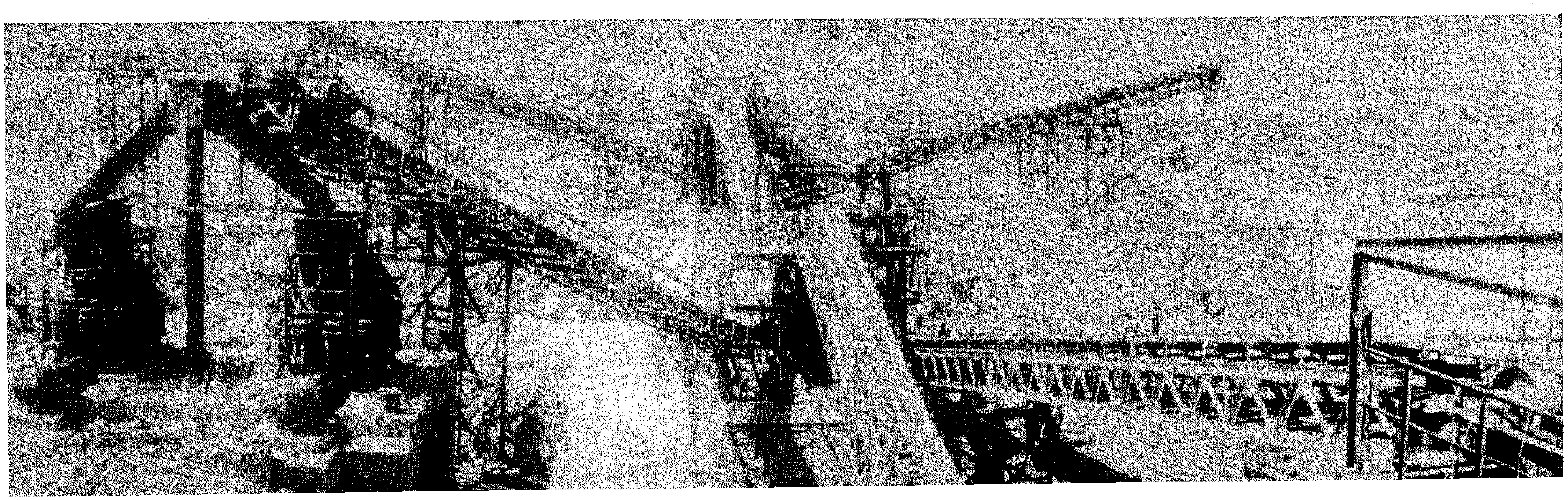


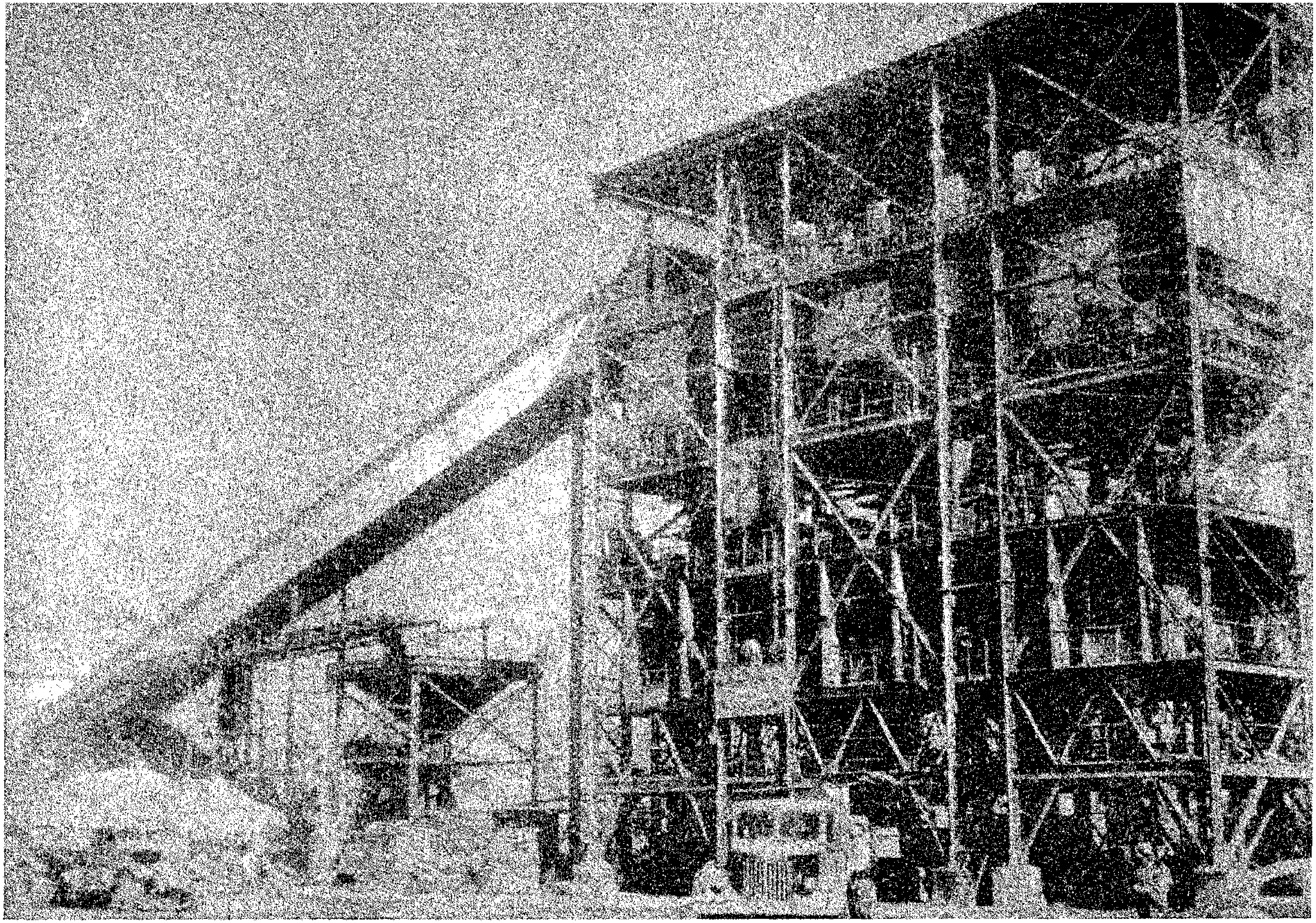
Filling of Pioneer prism No 4 and Sluicing and compaction of sand



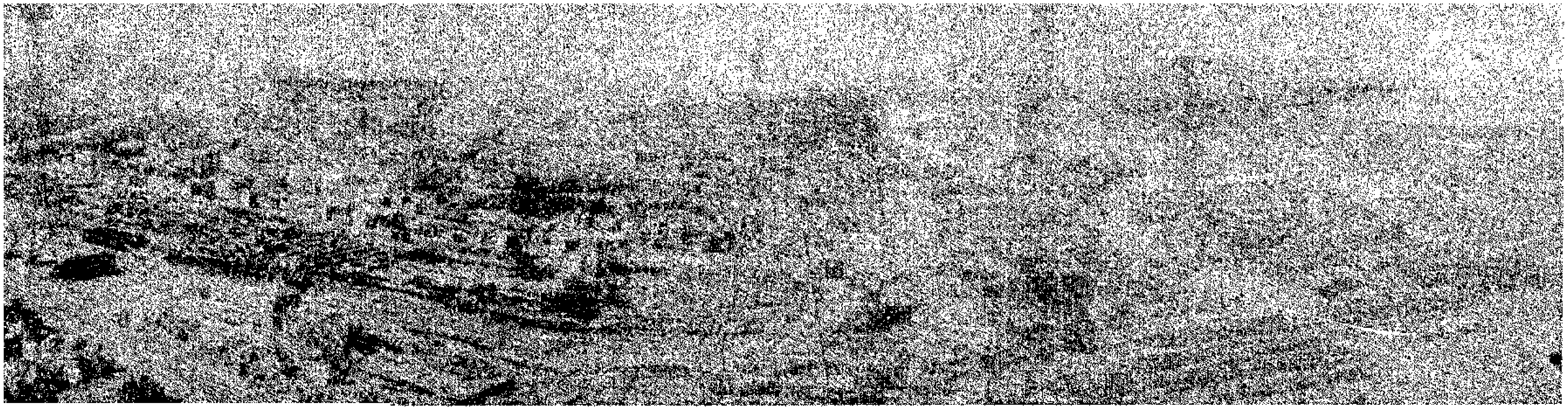
General view of stone crushing plant No. 1, Cement silos, cooling plant for crushed stone, and concrete mixing plant

Stone crushing plant No. 2.

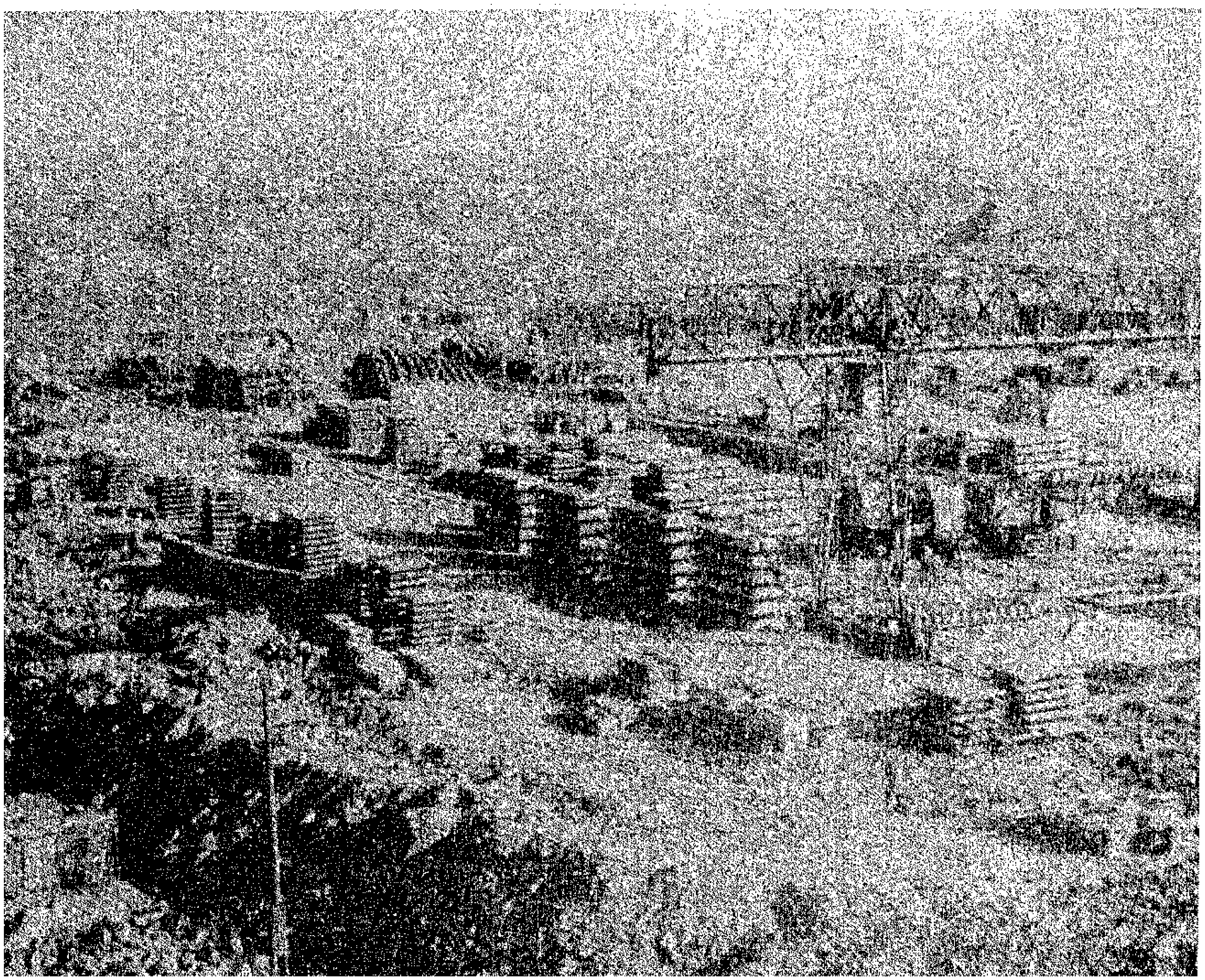




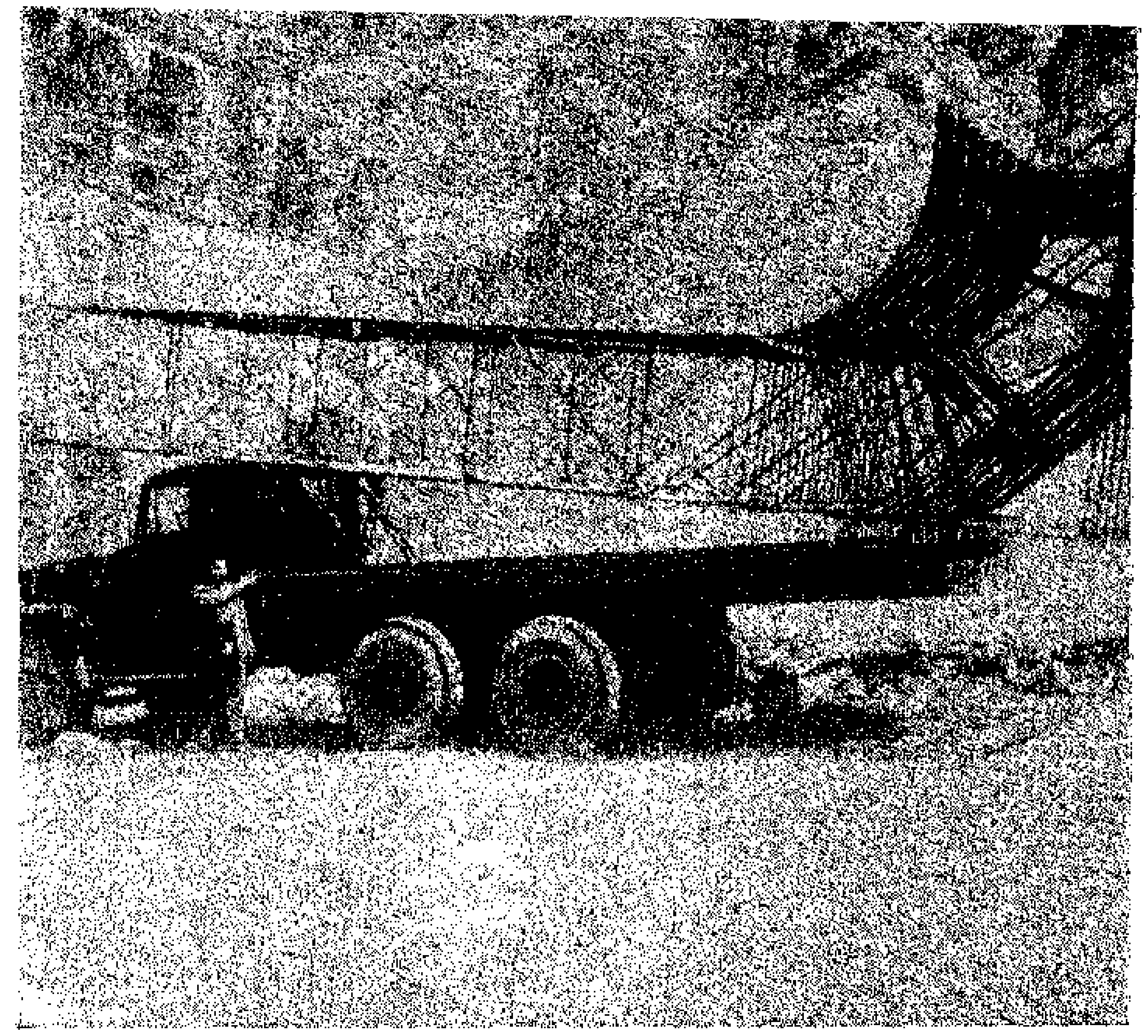
Concrete mixing plant.

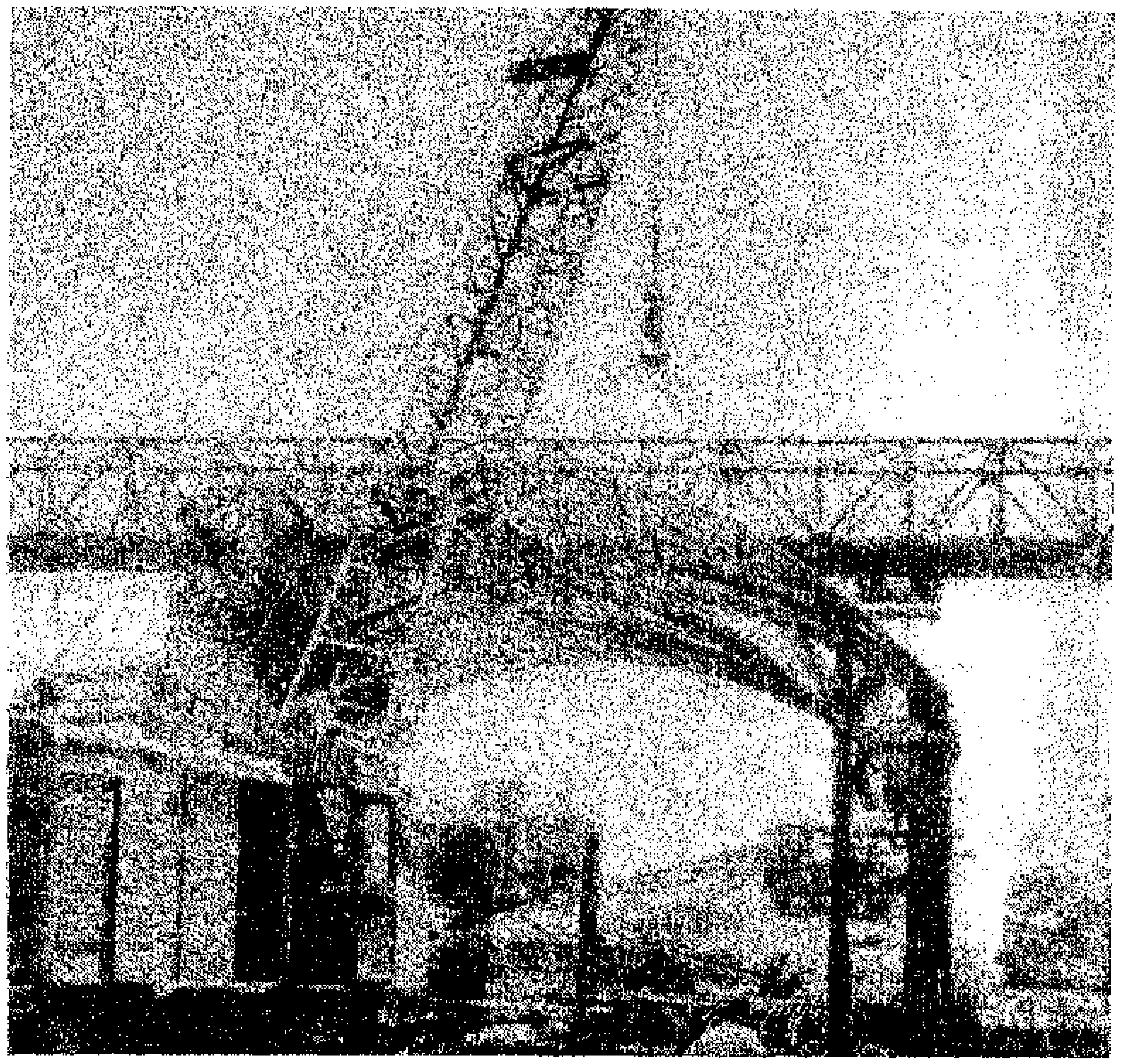


General view of the Mechanical Erection Yard.

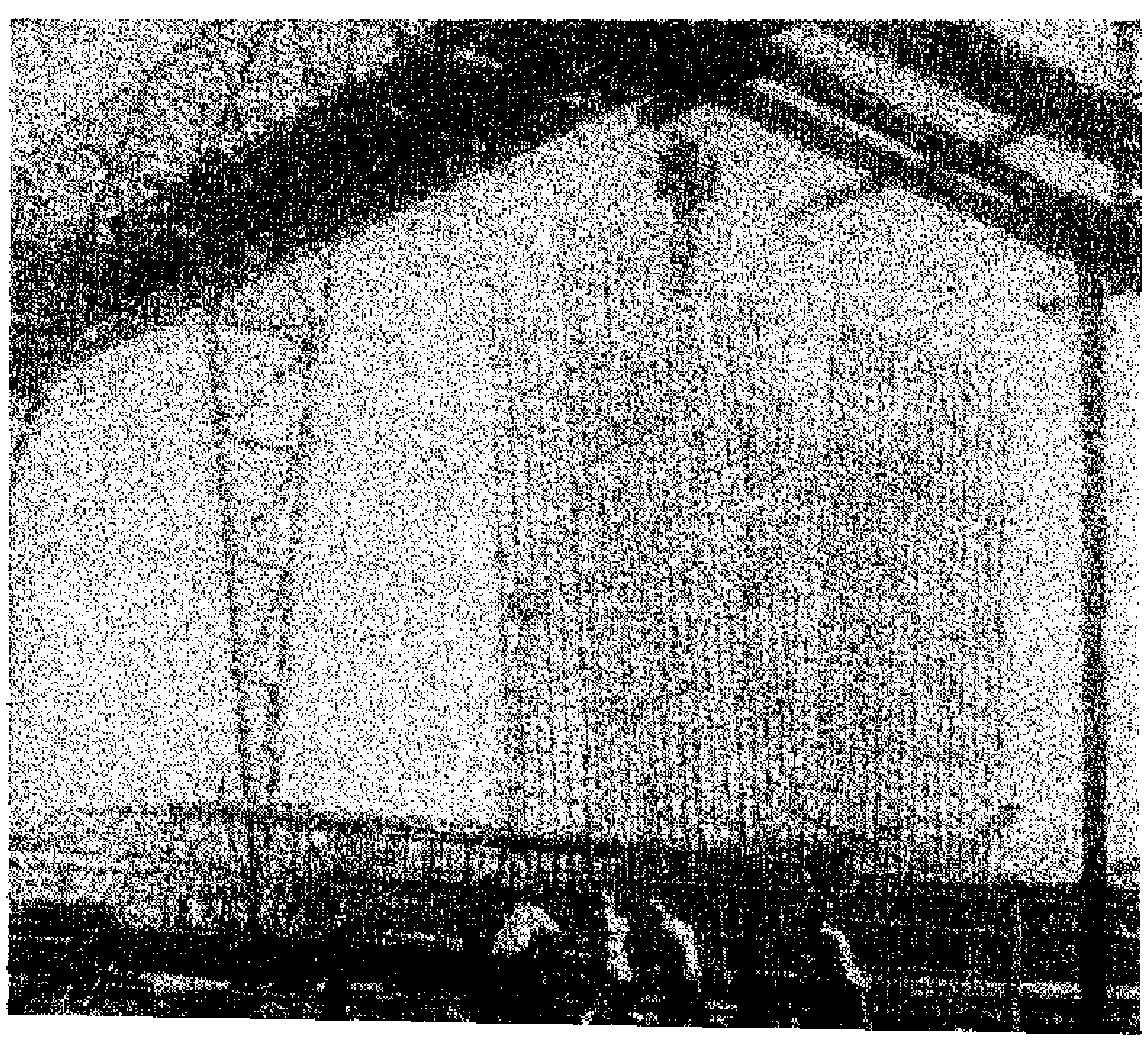


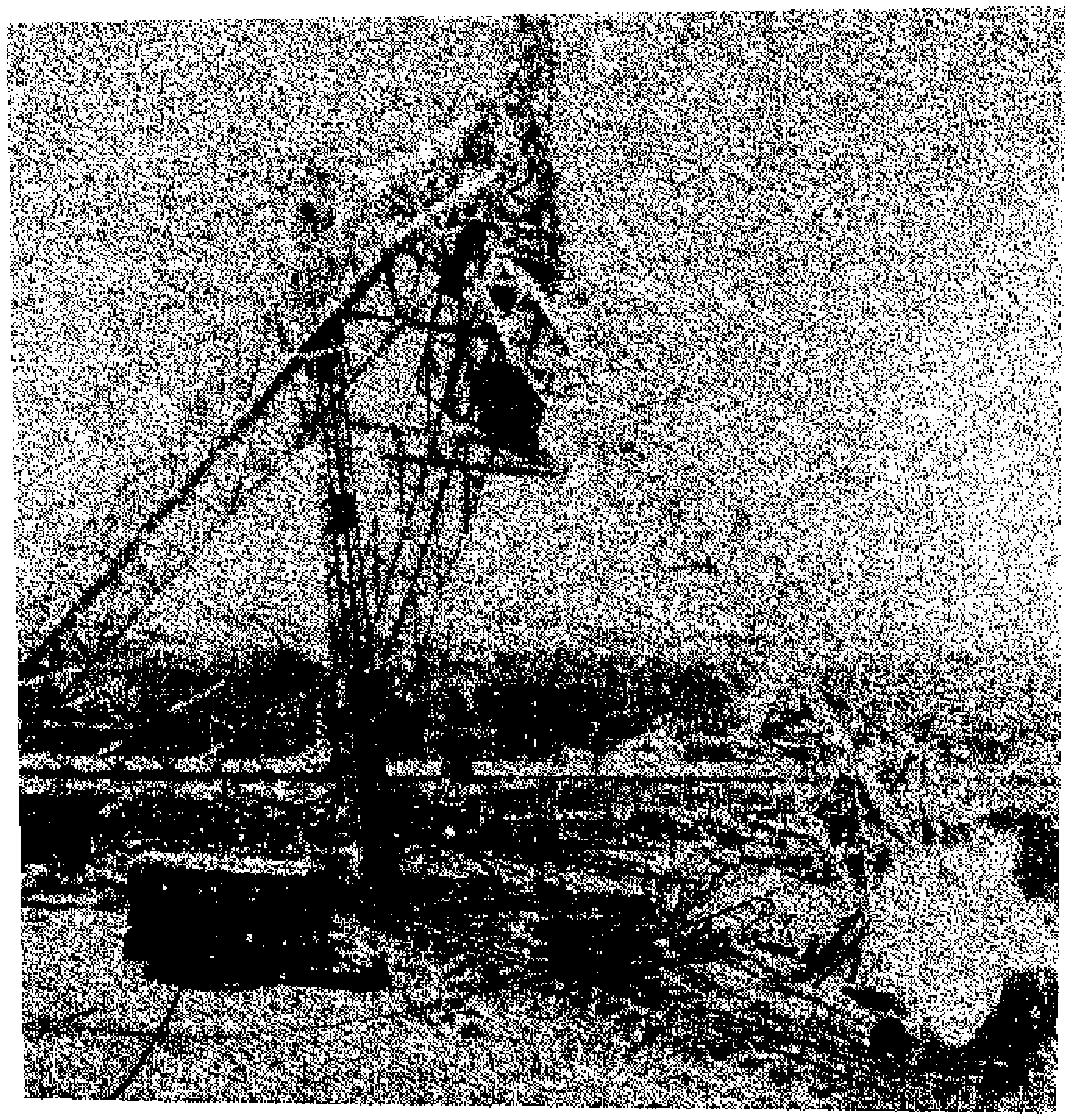
Prefabricated Reinforced Concrete yard

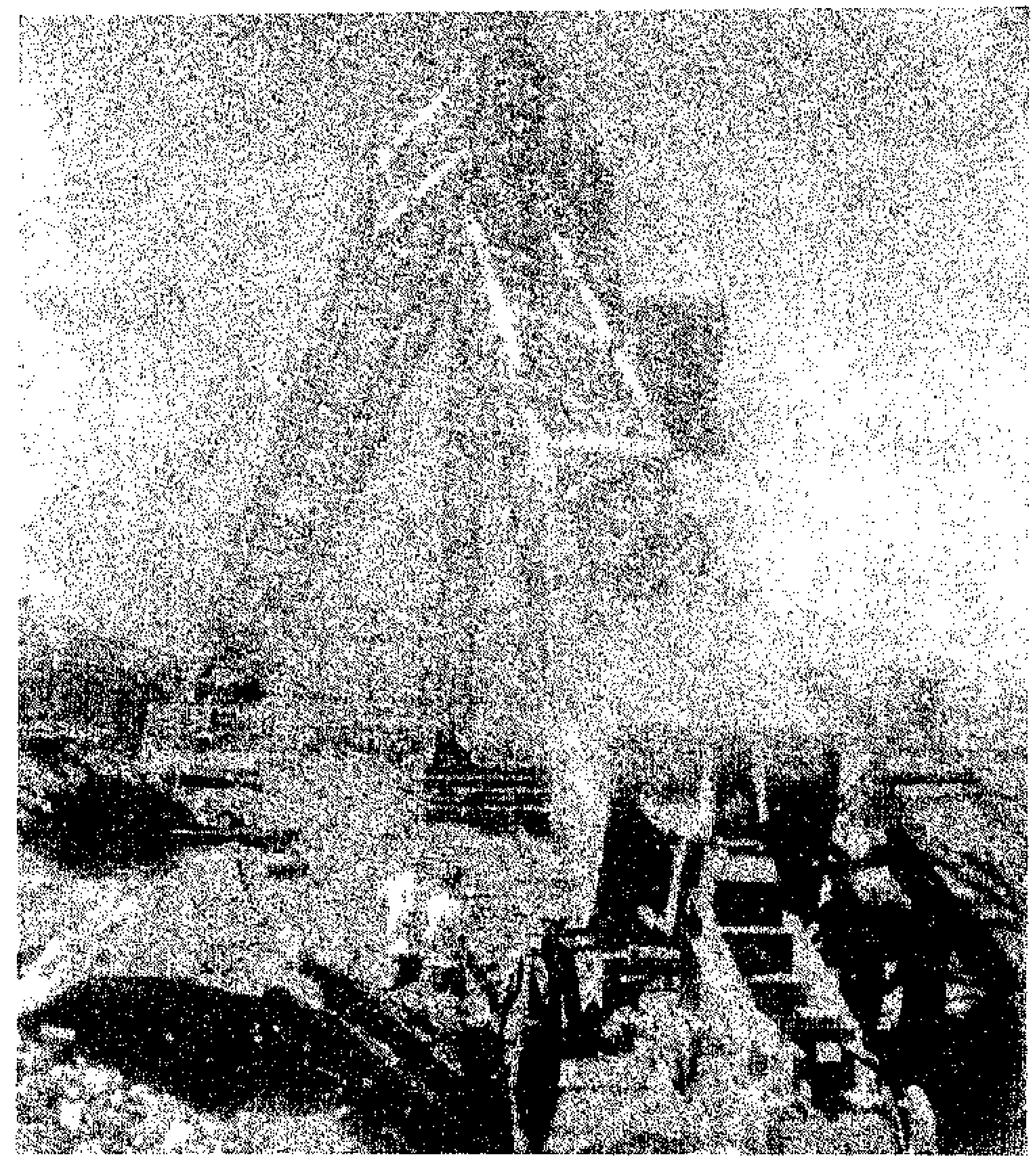




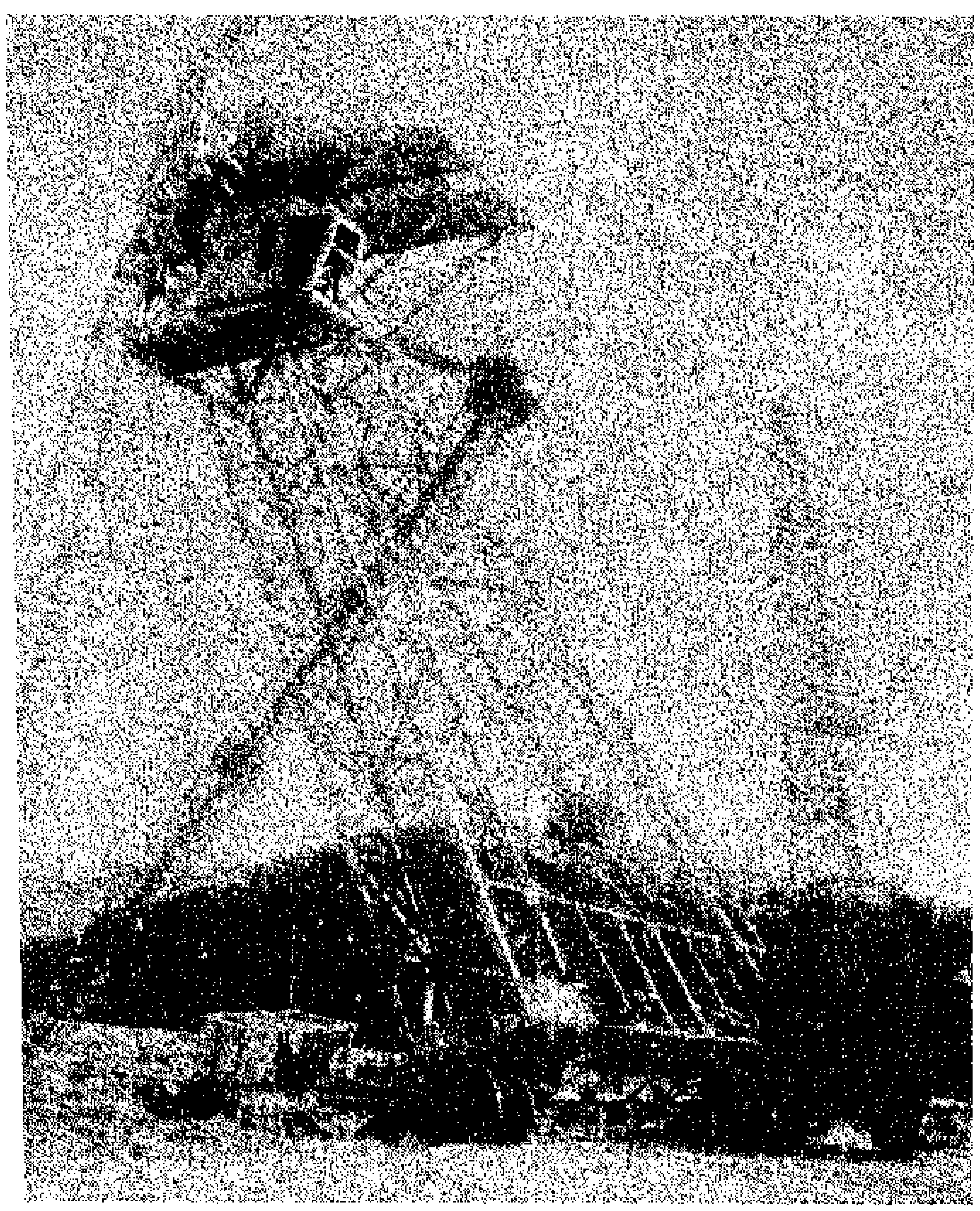
Transportation of the Steel reinforcement from the Mechanical Erection Yard to main structures.

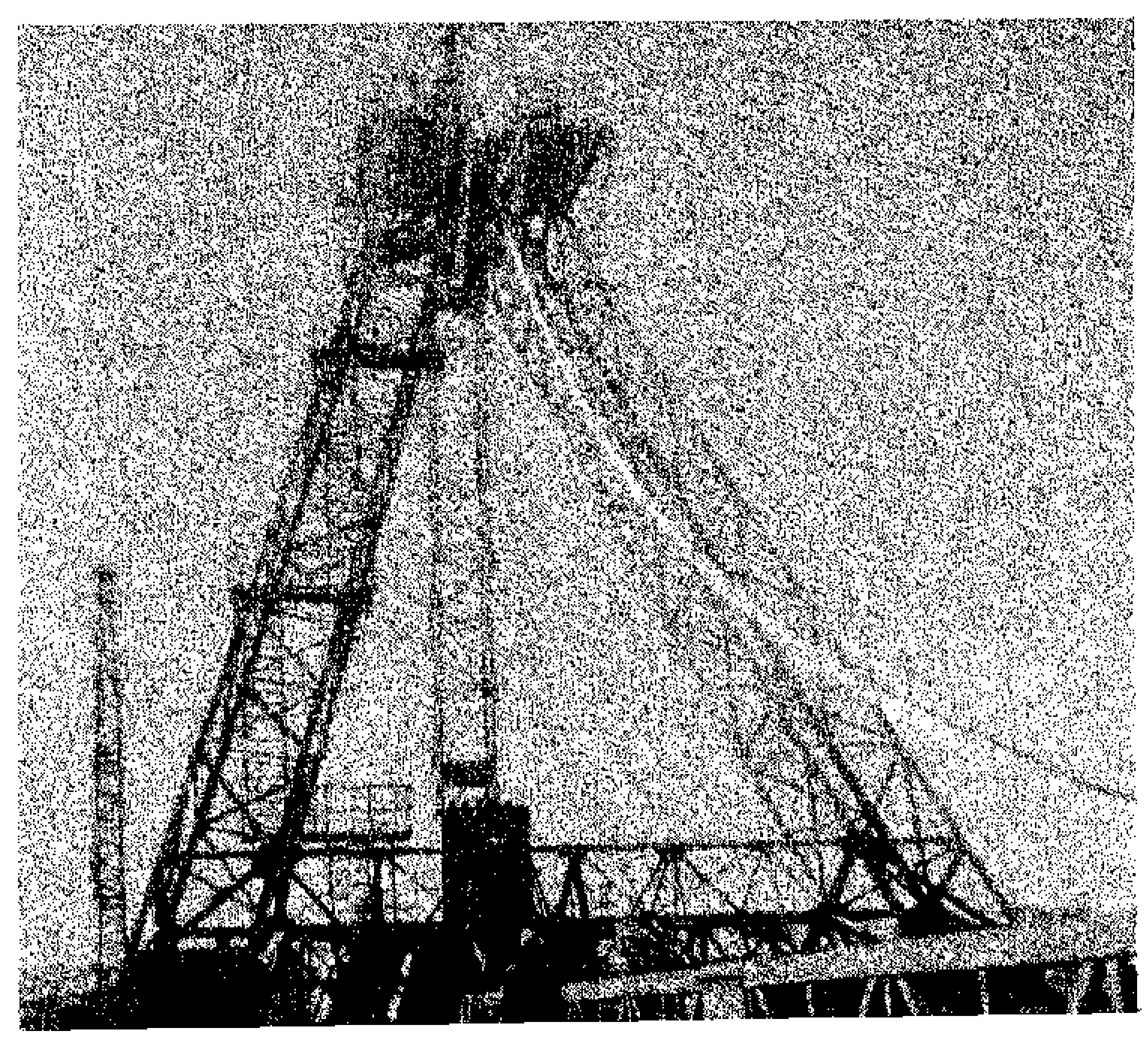




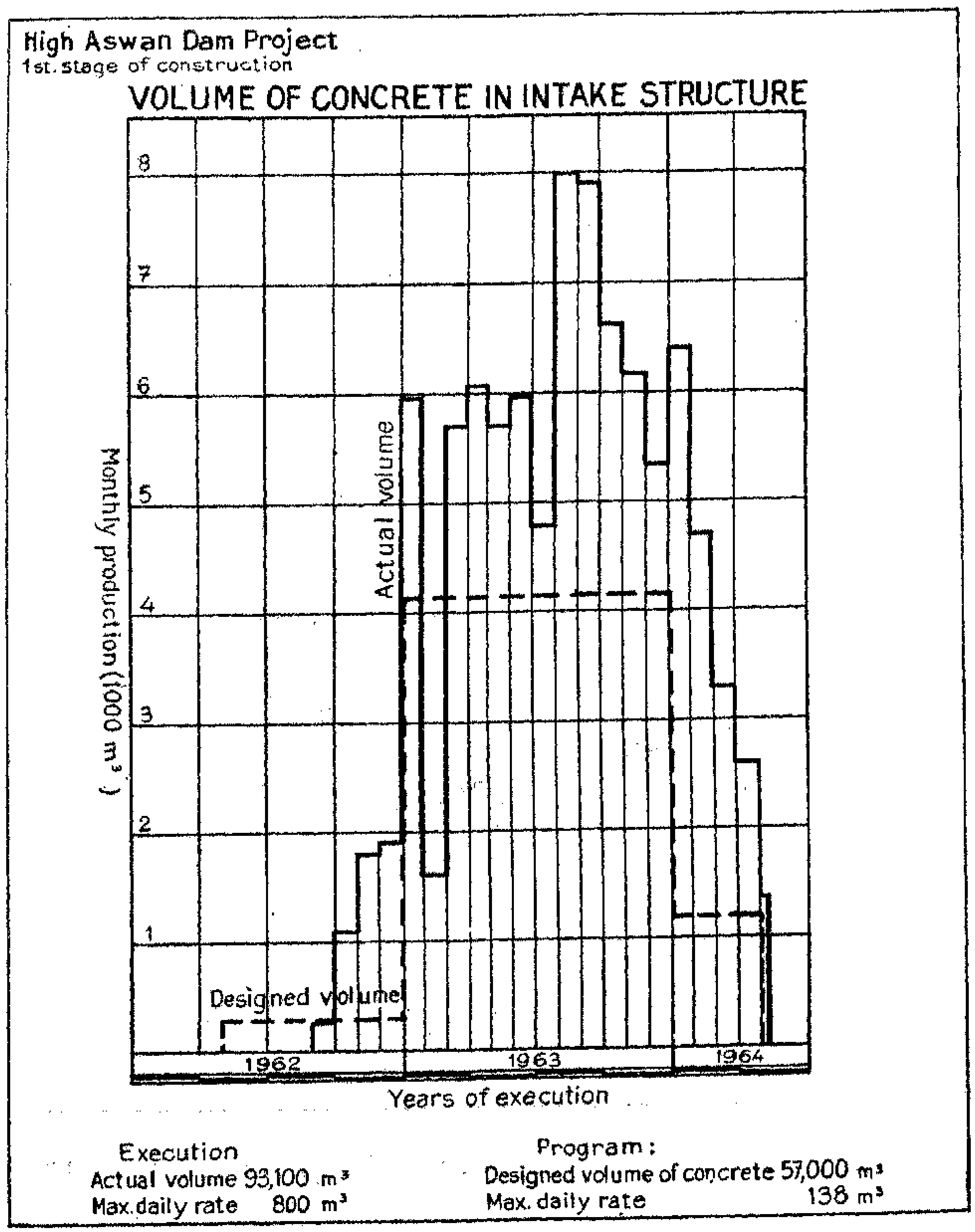


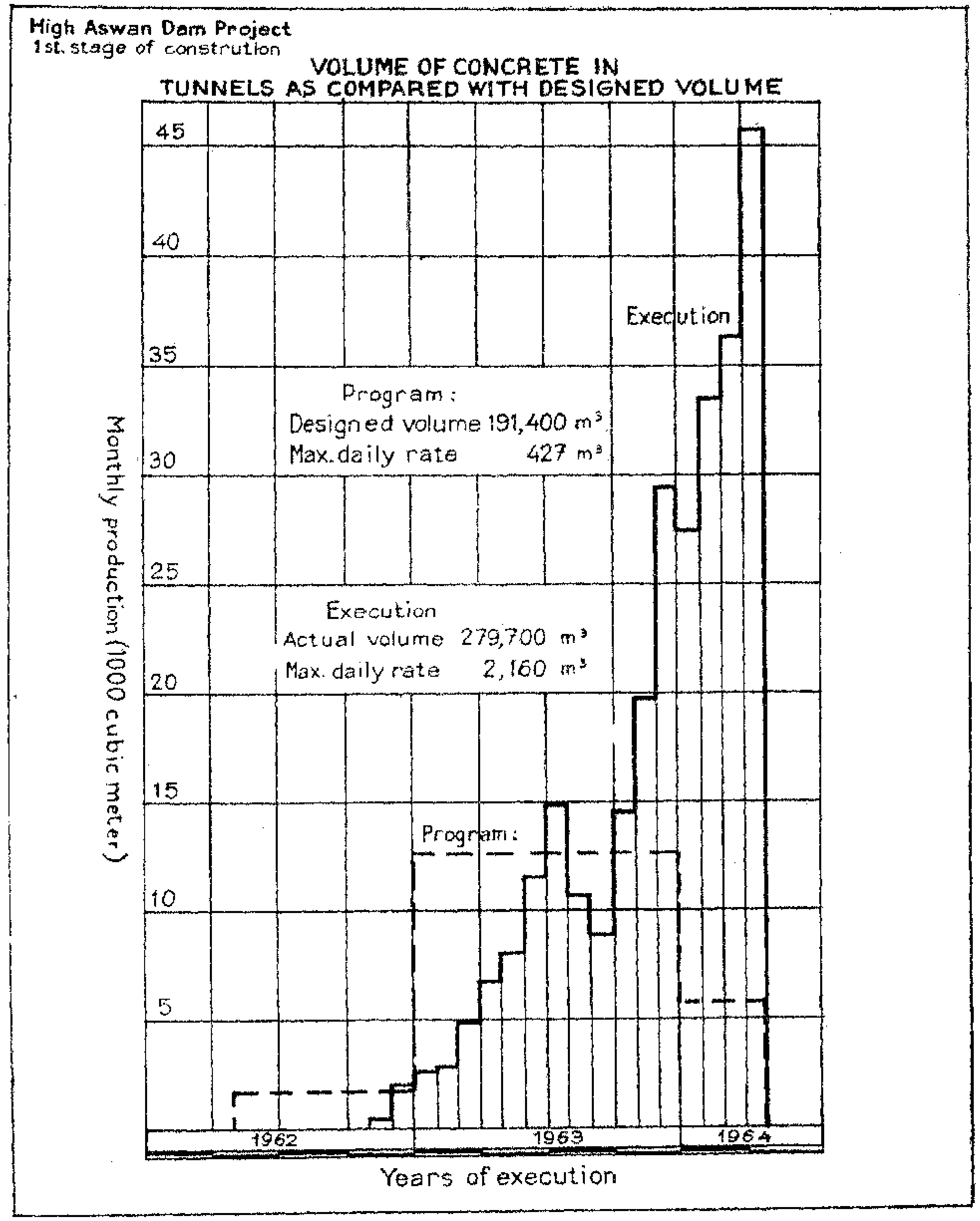
Erection of the Cable crane.





Diagrams of monthly production of concrete in Intake Structure & Tunnel



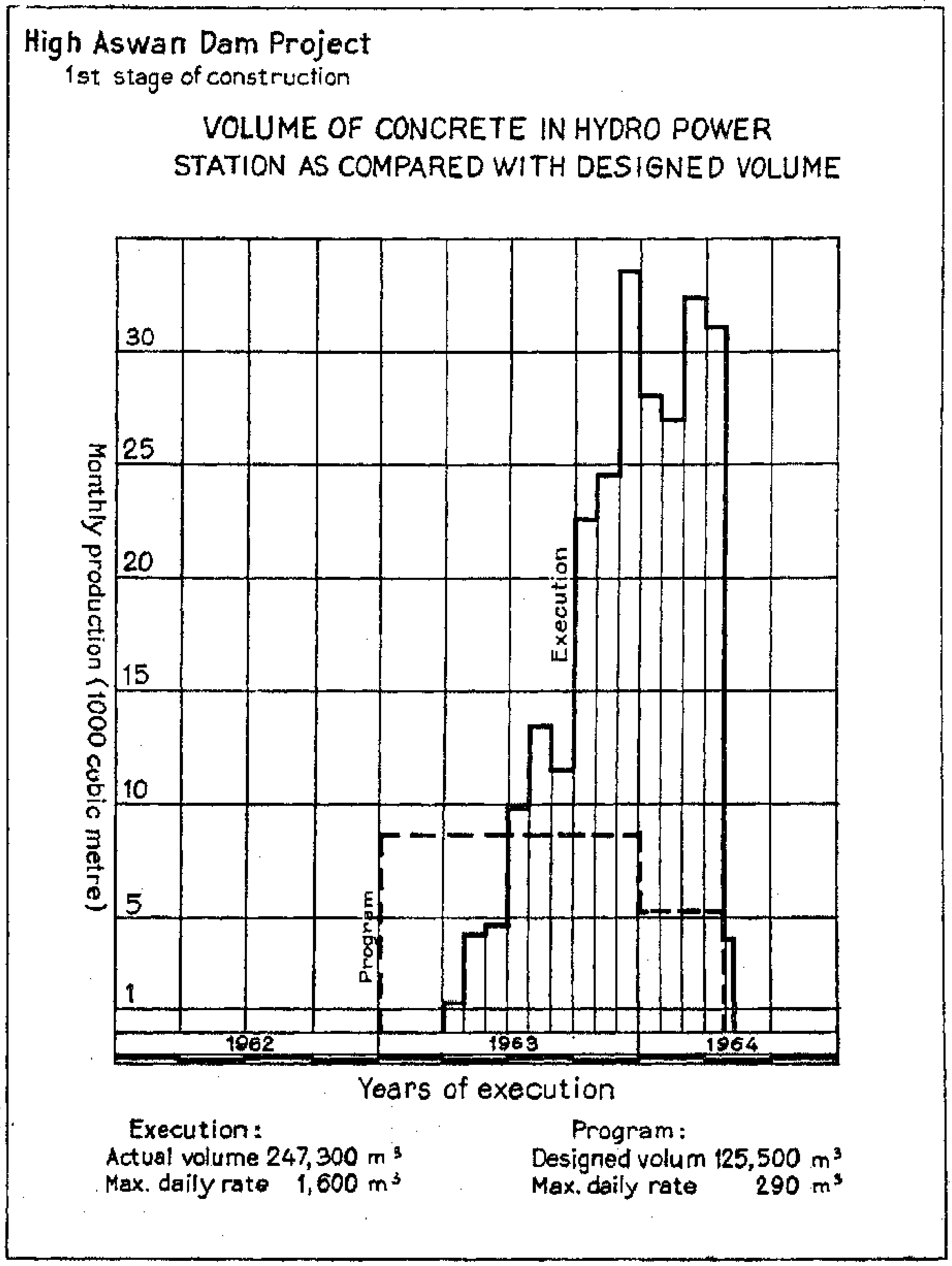



Diagram of monthly production of concrete in Hydro-Power Station

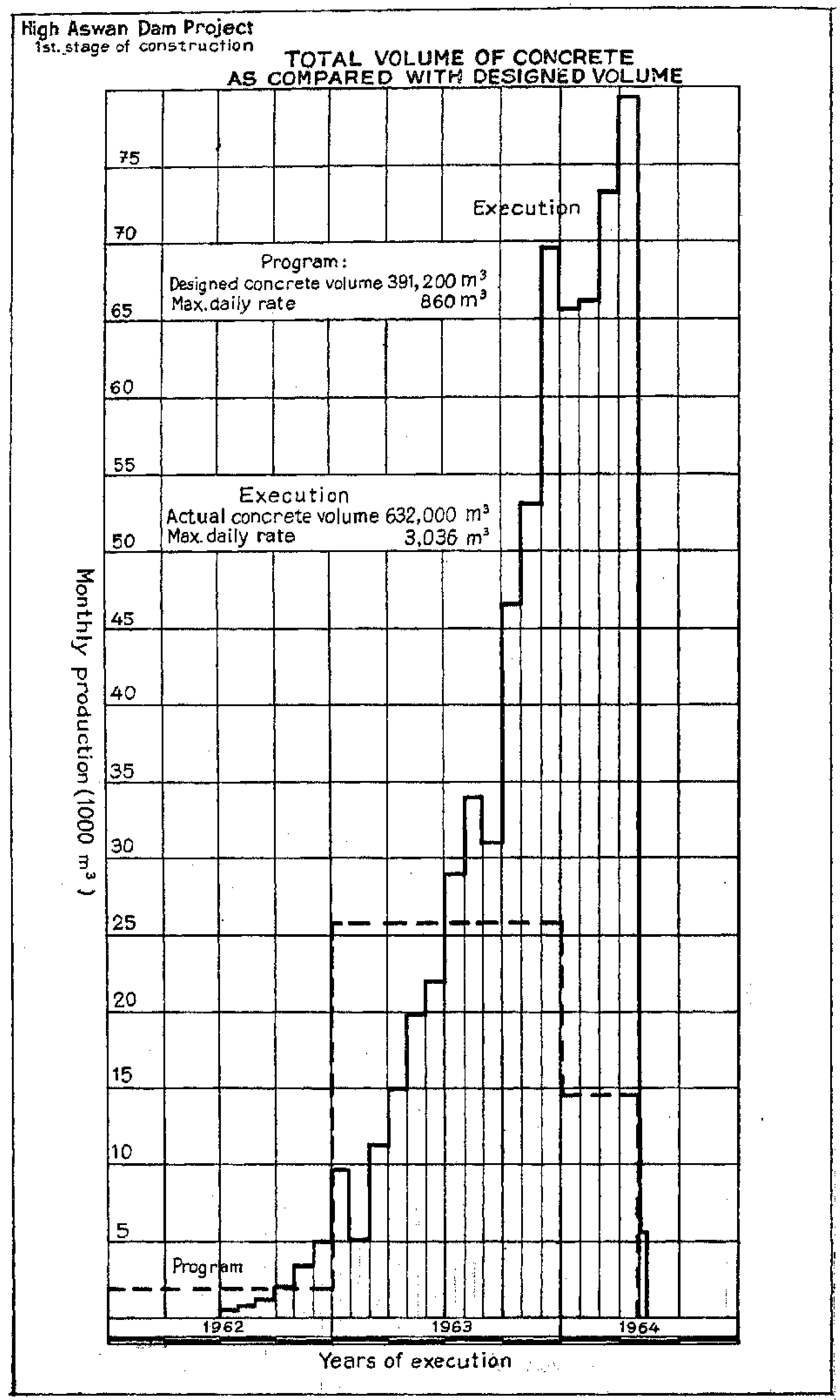
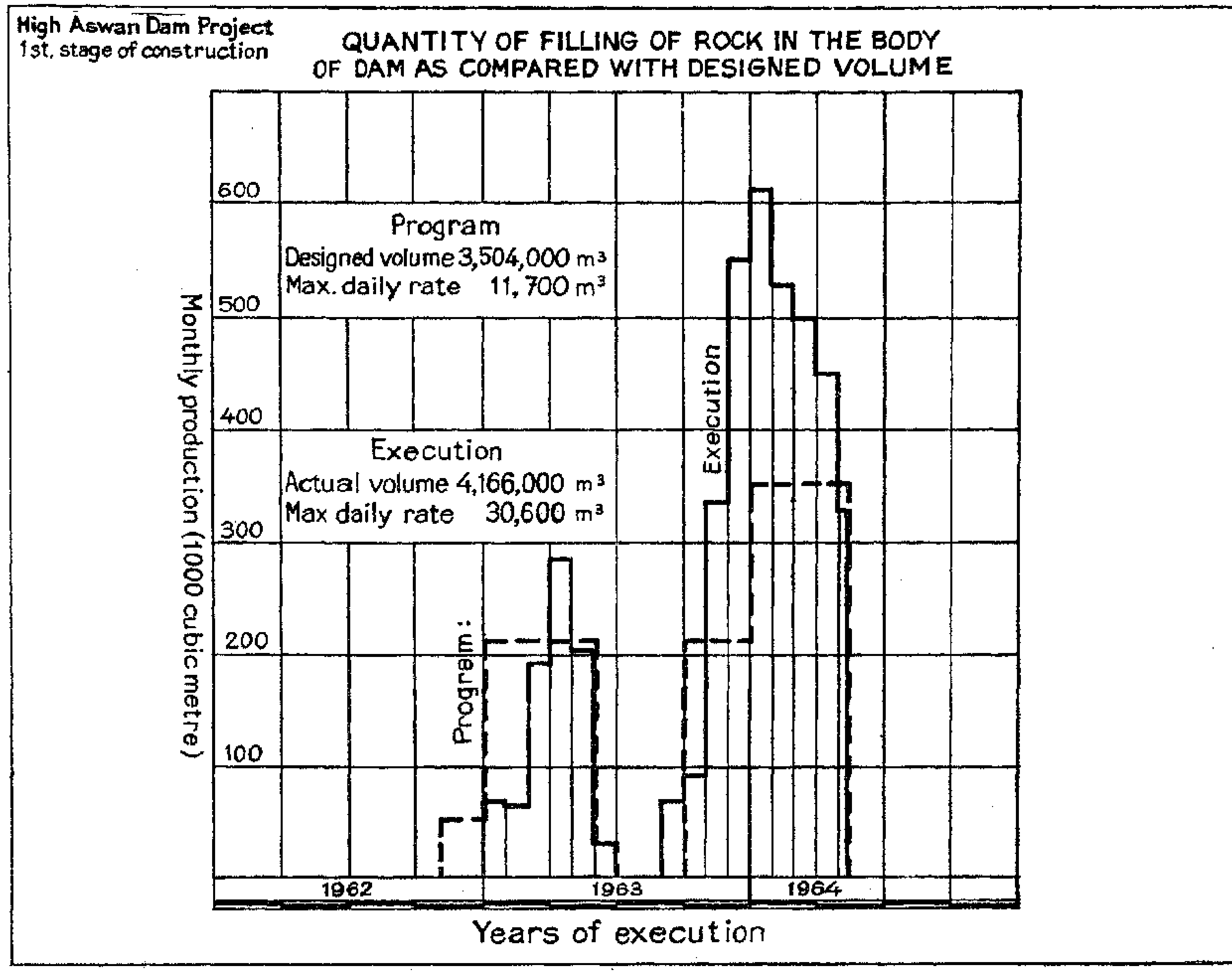
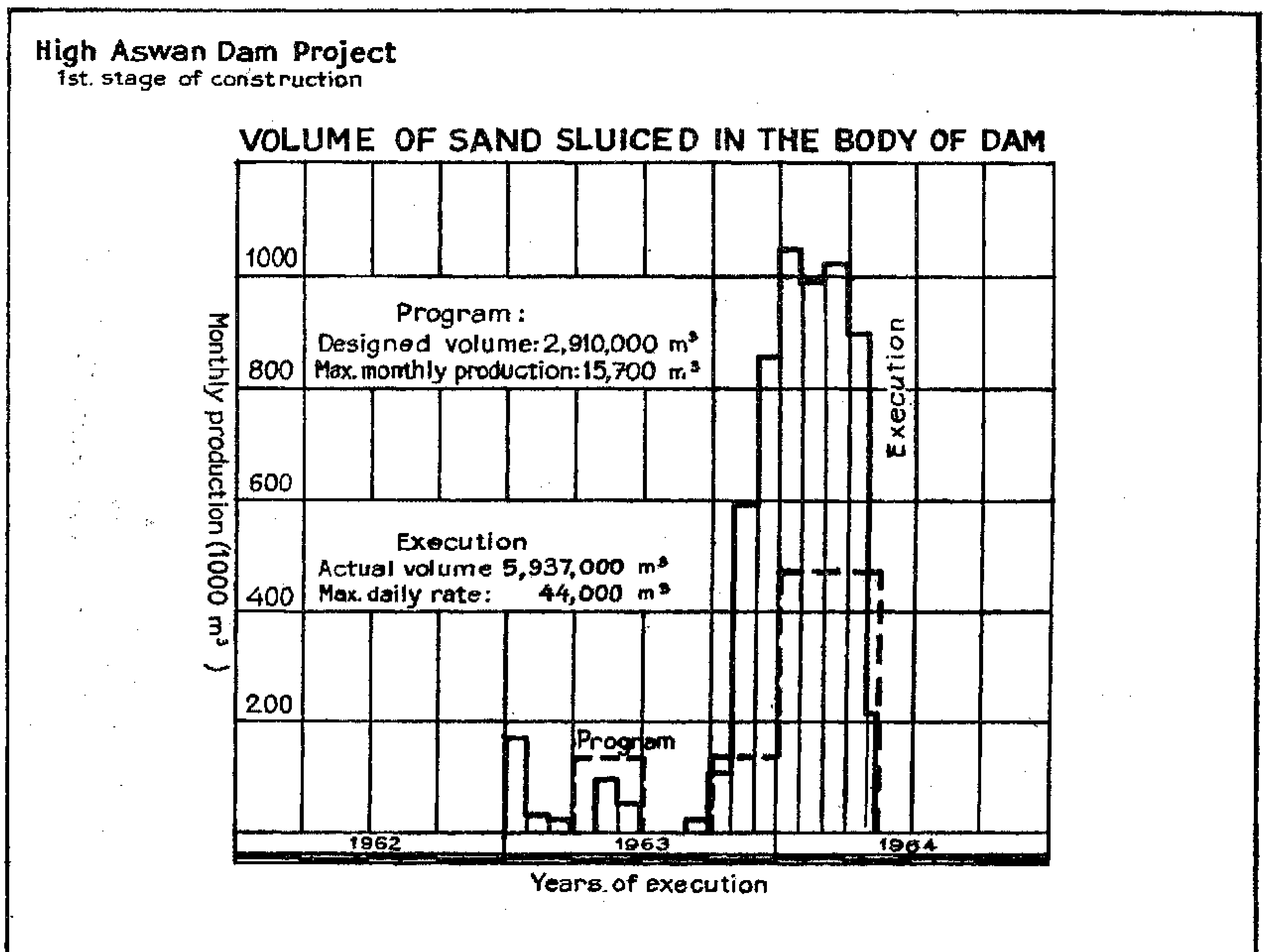
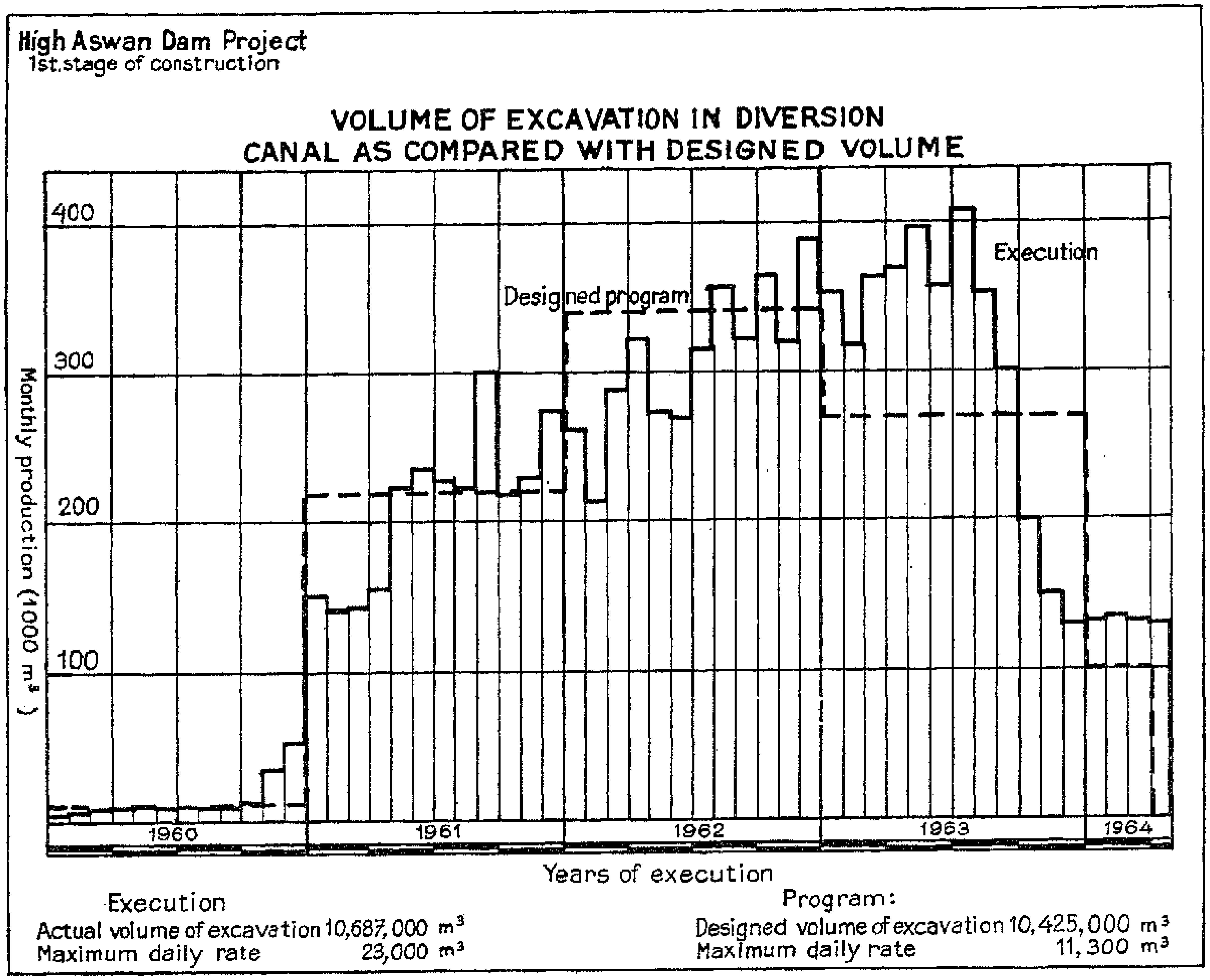



Diagram of monthly production of total concrete works

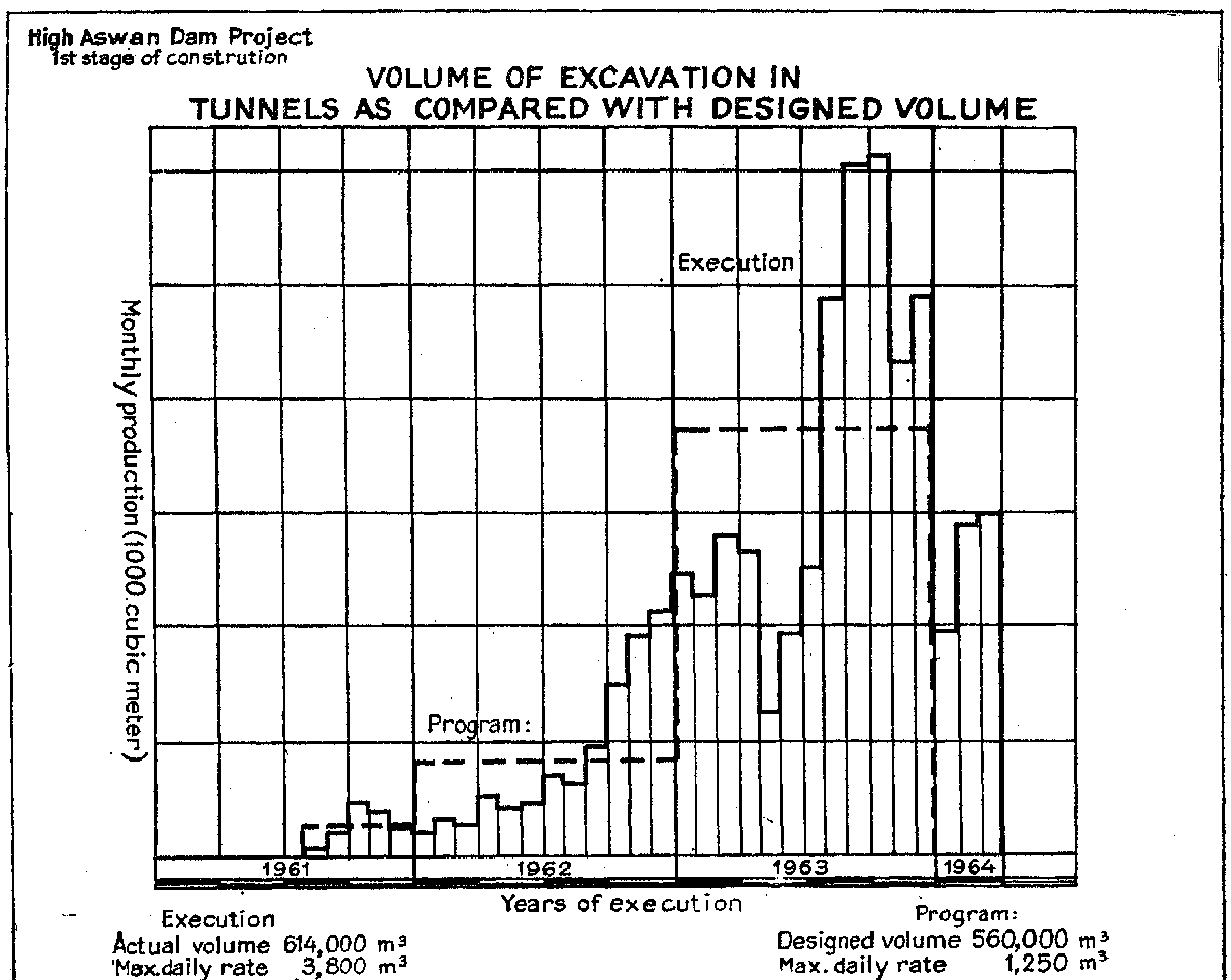
Diagrams of monthly production of filling of rock & sluicing of sand in the body of dam

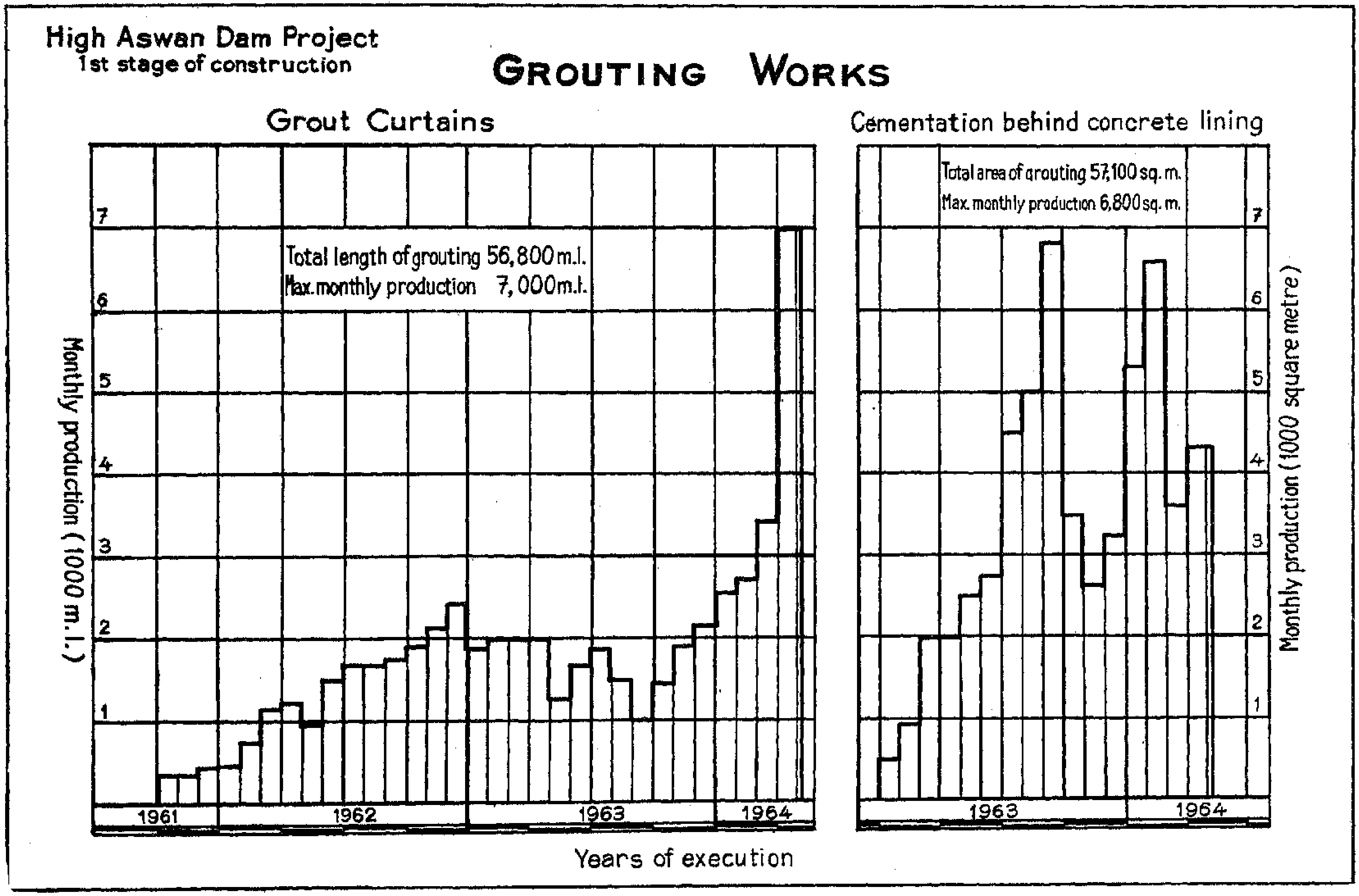


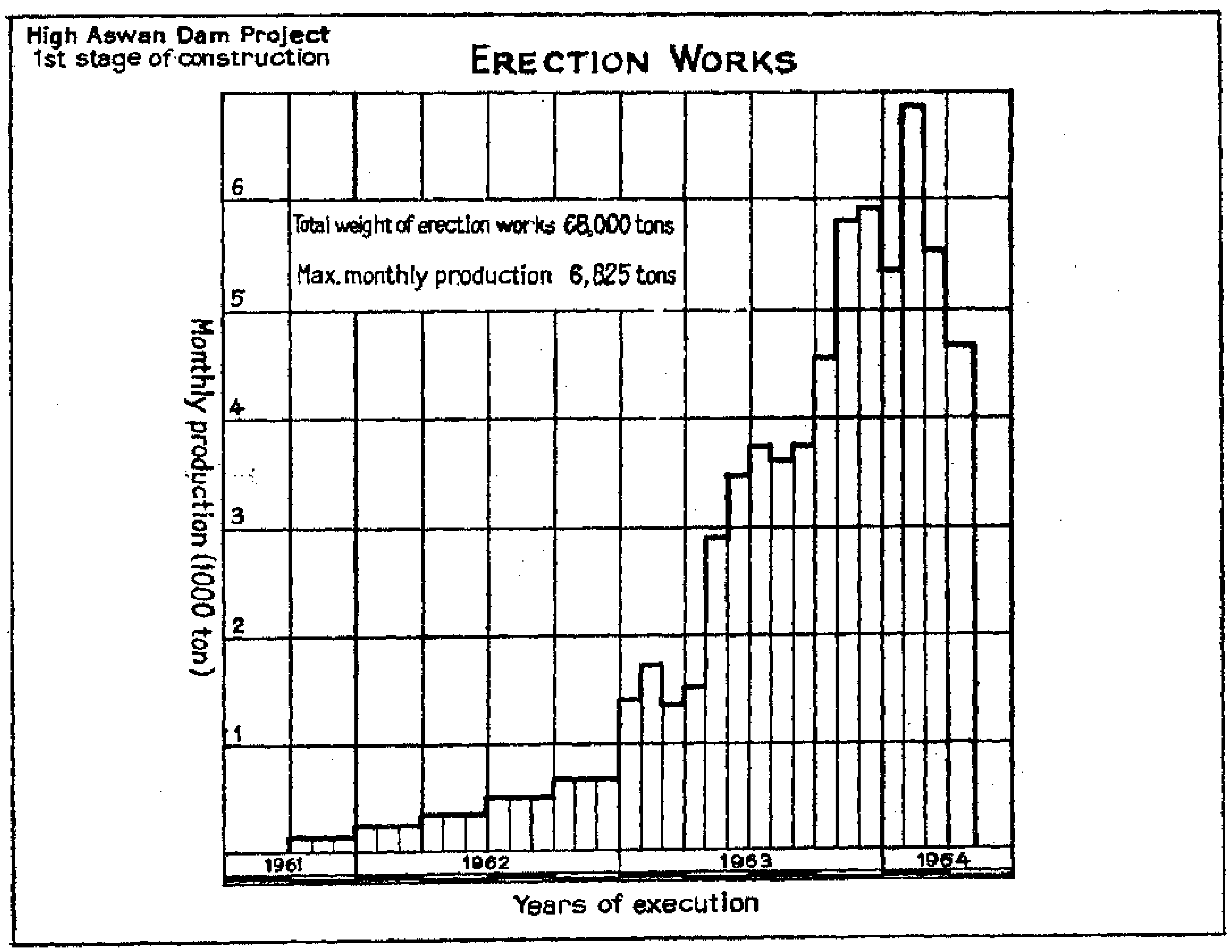






Diagrams of monthly production of excavation in Diversion Canal & Tunnels






Diagrams of monthly production of grouting works & mechanical erection works

## INJECTION WORKS

Injection works in the 1st Stage of the High Dam Project include:

a) Grouting of the rock faults, cracks and joints existing around the main structures to secure watertightness.

b) Grouting in tunnels to fill unavoidable hollows between concrete lining and rock to ensure additional solidity of the rock, diminish seepage and secure its interaction with reinforced concrete lining in sustaining the endured stresses as in the case of the tunnels. Grouting extended 7 meters behind the lining.

Water tight grout curtains in the rock are effected by drilling of 7.5 to 10 cm holes which are to be cement grouted. Grouting is being directed from outside inwards.

Pressure injection filling of space between concrete lining of tunnels and surrounding rock is made through 10 cm dia. pipes drilled in concrete. Injected materials are composed of cement, fine sand and bentonite mixed together with sufficient fluidity. Same mix was used in injection around steel embedded parts i.e. gate recesses, etc.

The following works were executed since October, 1961:

1) *Grout curtain in rock along axis of the right wing of the dam.*
   - Frontal curtain at tunnel inlets.
   - Grout curtain in the Nile abutments along the U.S. slope of the dam.
   - Grout curtain under the foundation of the power house.
   - Injection of virgin rock plug in D.S. canal.
   - Injection of rock abutments of temporary sand cofferdam. Total drilled length was 47,500 l.m. and cement consumption 5,200 tons.
2) *Rock strengthening injection, 7 m deep around tunnels.* Drilled length was 9,300 l.m. and cement consumption 730 tons.
3) *Injection filling between concrete lining of tunnels and rock.* Total area treated 42,000 $m^2$, cement consumption 8,500 tons.
4) *Injection filling around embedded steel parts.* Total area of embedded parts was 15,100 sq.m. and cement consumption 150 tons.

## MECHANICAL ERECTION

Several yards were prepared and equipped with necessary machinery, mechanical shops, cranes and equipment required for all kinds of steel works and mechanical erection. This organisation has undertaken the following works:

1) Formation, welding and erection of reinforcement steel required for the tunnels, power house, intake and all the project reinforced concrete works.
2) Erection of all construction equipment including cranes, screening plants, sand vibrating plants, etc.
3) Erection of all auxiliary works including the batching plant, the crushing plants, the compressed air, oxygen and water stations, workshops, etc.
4) Erection of all embedded parts, gates and their operating mechanisms at the tunnel intakes and power house.
5) Erection of the equipment of the drainage pumping station under the assembly bay.

The total fulfillment of the Mechanical Erection Organisation in the 1st Stage reached 68,000 tons of which 29,000 tons are steel manufacture and 39,000 tons erection works.

## TECHNICAL STUDIES AND RESEARCHES

As previously mentioned the High Dam project was subject to thorough studies and investigations. Several field and laboratory research works and experimental studies were conducted both locally and abroad.

These included:

a) Geologic, topographic and hydrologic studies for exploring the dam site and the potential resources of its construction materials.
b) Soil treatment researches and tests covering injection works, sand vibration and compaction as well as the core material and construction.
c) Model tests and researches for the determination of the optimum storage capacity, cavitation effects, scouring and sedimentation.

A wide range of studies and researches were conducted in Moscow by Hydroproject and in Aswan by the Research Centre. Models were constructed to solve all the technical and engineering problems encountered in the design and execution of the dam.

Besides, the Research Department undertakes the continuous quality control over all the materials used in construction to ensure their conformity with the specifications.

## AUXILIARY SERVICES

A big number of auxiliary installations and services were constructed in order to ensure the uninterrupted supply of the large and widespread works on the High Dam site with their needs of equipment and materials. The most important of these services are:

1) *Power Supply*

   The site is supplied with power from the Aswan Dam Power Station by means of two 132 kv transmission lines. Two transformer substations (20 and 10 thous. k.v.a.) are constructed to step down the voltage from 132 kv to the distribution voltage of 6 kv. A 6 kv network is laid covering the whole site and transformer substations are installed wherever and whenever necessary to step down the voltage to the required voltage of 3 kv, 380 or 220 volts.

2) *Concrete Batching Plant*

   An automatic batching plant having a daily capacity of 2600 $m^3$ of concrete is constructed, from which concrete is transferred to the working sites by means of special concrete trucks. Two crushing plants with a total daily capacity of 2500 $m^3$, supply the batching plant with the crushed granite required for the concrete aggregate. Four cement silos having a total storage capacity of 4,000 tons are installed beside the plant. A cooling plant is also installed to cool the water and crushed stone to the temperature required for concrete mixing. In order to meet the increasing concrete requirements another 500 $m^3$/day mechanical concrete mixing plant was installed.

3) *Workshops*

   Several workshops and garages were constructed and equipped with the necessary machines and tools for the continuous maintenance, repair and overhauling of all transportation and construction equipment.

   Several other auxiliary services were constructed including water purification plants, compressed air and oxygen stations, mechanical erection yards, main auxiliary stores for equipment and materials, a network of roads and railways, etc.

## EQUIPMENT AND MATERIALS

Up till May 1964 about 165,000 tons of equipment and materials have been imported from the Soviet Union for the High Dam. Some types of the equipment were designed and manufactured in the USSR specially for the High Dam Project, such as vibrofloat plants for undercurrent compaction of sand, self-discharging barges, etc. Besides, some of the requirements were covered by local supplies. The main construction equipment used in the project are:

| | |
|---|---|
| 16 | Electric excavators 4 $m^3$ each. |
| 74 | Diesel and electric excavators of different sizes. |
| 210 | Dumpers 25 t. |
| 90 | Dumpers 10 t. |
| 216 | Dumpers 5 t. |
| 77 | Dumpers 3.5 t. |
| 160 | Trucks (different capacities). |
| 38 | Mobile workshops and other special-purpose trucks. |
| 2069 | Drilling machines (different types and sizes). |
| 47 | Cranes (different types and sizes). |
| 1 | Cable crane 15 t. capacity. |
| 36 | Concrete pumps 40 $m^3$/hr and 10 $m^3$/hr. |
| 107 | Bulldozers. |
| 63 | Tractors. |
| 9 | Rollers (different types). |
| 16 | Pumping units for hydromechanization. |
| 22 | Barges (different types and capacities). |
| 3 | Vibro floating plants. |
| 24 | Motor boats. |
| 4 | Floating water dredgers. |
| 80 | Portable Air Compressors. |
| 36 | Pumping units for injection. |

## VOLUMES AND RATES OF MAIN WORKS FULFILLED TILL THE NILE CLOSURE

| Sl. No. | Description of Works | Unit | Fulfillment till 15-5-1964 | Max. Monthly Production | Max. Daily Rate |
|---|---|---|---|---|---|
| 1 | Canal excavation | $m^3$ | 10,687,000 | 408,800 | 23,000 |
| 2 | Tunnel excavation | " | 614,000 | 61,300 | 3,800 |
| 3 | Concrete for Intake Structure | " | 93,100 | 8,000 | 800 |
| 4 | Concrete for tunnel lining | " | 279,700 | 44,100 | 2,160 |
| 5 | Concrete for Power House | " | 247,300 | 33,600 | 1,600 |
| 6 | Total concrete production | " | 632,000 | 82,700 | 3,225 |
| 7 | Rock dumping in Nile | " | 4,166,000 | 611,400 | 30,600 |
| 8 | Sand sluicing in Nile | " | 5,937,000 | 1,045,000 | 44,000 |
| 9 | Sand sluicing stockpiling by hydromechanization | " | 6,171,800 | 508,000 | |
| 10 | Transportation of sand by railway | " | 1,391,000 | 217,200 | 11,400 |
| 11 | Mechanical erection and manufacturing | ton | 68,000 | 6,825 | |
| 12 | Injection of rock | l.m. | 56,800 | 7,000 | |
| 13 | Injection behind tunnel lining | $m^2$ | 57,100 | 6,800 | |

## MANPOWER

The total labour force working at the project and all its auxiliary works increased from 15,000 persons in December 1962 to 34,000 persons in 1964. More than half of this number are skilled labour.

The recruitment of skilled labour was extremely difficult especially in certain trades due to the high demand for them in other projects. This difficulty was mainly overcome by vocational training on the job to upgrade the skills of the existing and newly introduced labour, and in the training centres. During the year of 1963 the training activities covered about 6,000 men. The High Dam Authority has recently prepared a new modern training center at Aswan to accommodate about 4,000 labours annually to be trained for different periods in 15 different mechanical and electrical trades. The center is furnished with Soviet equipment.

The High Dam Authority adopted a number of incentives which were effective in attracting the skilled labour. These include: higher wages, free lodging and medical care for the builders and their families, subsidized meals, extra insurance and pension arrangements, regular leaves with free tickets to and from the town of origin.

## ORGANIZATION PARTICIPATING IN CONSTRUCTION

The High Dam Authority is responsible for the execution of the project.

A good part of the work has been carried out by leading Egyptian contracting companies who proved very capable in carrying out their responsibilities.

All open rock and soft soil excavation in the canals, development of coarse sand, rock quarries and dumping of rock in the Nile for the construction of the Dam body were carried out by the Arab Contractors Company.

"The Misr Concrete Co." has carried out the production of all concrete and its delivery to all works and the construction of the reinforced concrete power house and intake structures.

Several other Arab Companies have participated in the construction of roads, railroads, dwelling, settlements and the auxiliary facilities. Of these companies are:

— The Industrial & Engineering Projects Co.

— The Tractor & Engineering Co.

— The General Nile Co. for Construction of Roads.

The High Dam Authority has undertaken the fulfilment of the specialized works for which it has formed within its organization specialized departments from Arab and Soviet personnel. These are the "Tunnel Department," the "Mechanical Erection Department," the "Hydromechanization Department" and the "Injection Department," which fulfilled all the corresponding works previously explained in this text.

Furthermore, the Authority has undertaken the supply services of equipment, materials and spare parts for all the participating organizations; the construction, running and maintenance of all the auxiliary plants and facilities; the research, coordination and control works, the recruitment and training of personnel; public services and all the other works of general use to the dam builders.

All the works of the project run according to programmes prepared by the "Planning Department" of the Authority.

General, annual and monthly programmes are prepared and discussed with all the parties concerned and then approved by the Chieves of the Authority and Soviet Experts and then issued for execution. A close system of follow-up of the works and reporting is adopted, according to which the necessary measures are taken for immediate rectification of deviations and solving the working problems.

## SOVIET CO-OPERATION IN THE PROJECT

The first agreement between the Government of the U.A.R. and the Soviet Union was concluded in December 1958. It stipulates that the two Governments cooperate in the construction of the first stage of the High Dam Project. To achieve this purpose, the Soviet Specialized Agencies undertake the performance of the necessary design studies and researches and the supply of construction equipment, gates; equipment, machinery, spare parts and materials which are not available in the U.A.R. To cover the expenses of these commitments, the Soviet Government rendered the U.A.R. Government a loan amounting to 34.8 million Egyptian Pounds to be paid on twelve annual instalments starting from 1964 at an interest of 2.5%. In August 1960 the second agreement was concluded between the two Governments rendering an additional loan of 78.4 million pounds for the completion of the second stage of the project covering the supply of generating units and transmission lines and all the other works of the second stage.

In pursuance of the agreements between the Governments of the U.A.R. and the U.S.S.R., the Chief Soviet Expert's Administration was set up to realize the technical assistance in the construction of the High Dam. This Administration works within the framework of the High Dam Authority.

After the first agreement was concluded in 1958, the Soviet Engineers Organization "Hydroproject" cooperating with Arab engineers, started to deal with all research and design works as well as the preparation of all working drawings for the main structures, under the supervision of Mr. N. Malyshev, the Chief Design Engineer of the Project.

The "Leningrad Steel Plant" designed the turbines and will supply them.

The alternators will be supplied by the "Leningrad Electrocila Plant" which designed them.

The "Gidromontazh" trust of the U.S.S.R. State Energetics and Electrification Committee designed and manufactured at the trust's factories all hydromechanical equipment.

The Soviet Specialized Organisation contributed with the Arab builders in carrying out tunnels, mechanical erection, hydromechanization and injection works.

The Soviet personnel who formed an integrated part of those specialized organizations were deputed to the U.A.R. from the Soviet State Trusts "Gidrospetsstroi," "Gidromontazh" and "Gidromechanizatsiya." These trusts are famous in the U.S.S.R. of a high level execution of specialized works.

Over 1800 Soviet experts cooperated closely with their Arab colleagues in an atmosphere of friendship and deep sense of responsibility for achieving their common targets.

Mr. P. Niporozhny, Chairman of the U.S.S.R. State Energetics & Electrification Committee together with Mr. A. Alexandrov, Chief Soviet Expert at Aswan and their assistants helped considerably in creating such high spirit through their personal keen interest in the High Dam works.

Over 300 Soviet factories cooperated in the manufacture of various equipment for main structures, as well as construction equipment and materials.

The Committee for State Energetics & Electrification has formed within its framework a special department, "Aswan Spetsstroi," to follow up the execution of specialized civil and erection works, place orders with manufacturers, inspect and accept manufactured equipment.

follow up the supplies to the U.A.R. and select the Soviet specialists to be deputed to the High Dam.

Supplies of the necessary Soviet equipment and materials went through the All Union Export-Import Corporation "Technopromexport of the U.S.S.R. State Committee for foreign economic relations.

About 165,000 tons of equipment and materials were supplied to the project from the U.S.S.R. and transported to the U.A.R. by both Arab and Soviet Ships. Among the supplies of equipment and materials, the following well known plants are noted:

Ural Machine-Building Works "UZTM"

Minsk Automotive Works.

Belorussian Automotive Works.

Kremenchug Automotive Works.

Voronezh Excavator Works.

Chelyabinsk Tractor Plant.

Chekhov Steel Construction Works.

Kharkov Electromechanical Factory.

"Electroapparat" Factory.

Zaporozhye Transformer Works.

Magnitogorsh Iron & Steel Complex.

Yaroslavlj Tyre Works.

## PROSPECTS OF THE SECOND STAGE

The second stage of construction includes:

1. Completion of the High Dam body to its final profile.
2. The supply and erection of generating units, switchgear and all other installation of the power station.
3. The installation of transmission lines, transformer stations and their switchgear and accessories.

The two stages of construction are actually interconnected and work is proceeding uninterruptedly.

It was originally scheduled to finish the dam body completely in 1968 and the power station in 1970. But due to the high rates attained in the first stage the situation is being revised and a new programme is under preparation to economise one year from the second stage i.e. finish the dam in 1967 and the power station by 1969.

# TECHNICAL DATA

## *HYDROLOGY*

| | | |
|---|---|---|
| Nile discharge at Aswan: | | |
| Maximum | 13,500 | $m^3$/sec. |
| Minimum | 275 | |
| Mean annual flow at Aswan | 84,000 | mill.$m^3$ |

## *D A M*

| | | |
|---|---|---|
| Total length of crest | 3,600 | m |
| Length of part in river | 520 | m |
| Length of right wing | 2,325 | m |
| Length of left wing | 755 | m |
| Maximum height above bed level | 111 | m |
| Width of dam base | 980 | m |
| Width of dam crest | 40 | m |
| Level of dam crest | 196 | m |
| Level of core crest | 186 | m |
| Level of core base | 124 | m |
| Height of core | 62 | m |
| Width of core crest | 10 | m |
| Width of core base | 60 | m |
| Depth of injection curtain | 180 | m |
| Upper width of injection curtain | 40 | m |
| Lower width of injection curtain | 5 | m |

## *RESERVOIR*

| | | |
|---|---|---|
| Max. storage level | 182 | m |
| River bed level at dam site | 85 | m |
| Total reservoir capacity | 157,000 | mill. $m^3$ |
| Dead storage capacity | 30,000 | " |
| Flood control storage capacity | 37,000 | " |
| Operational capacity | 90,000 | " |
| Annual guaranteed live storage | 84,000 | " |
| Annual evaporation and seepage losses | 10,000 | " |
| Net live storage | 74,000 | " |
| U.A.R. annual water share | 55,500 | " |
| Sudan annual water share | 18,500 | " |
| Length of reservoir lake | 500 | km |
| Average width of reservoir lake | 10 | " |
| Surface area of reservoir lake | 5,000 | $km^2$ |

## *DIVERSION CHANNEL*

| | | |
|---|---|---|
| Length of U.S. canal | 1,150 | m |
| Length of D.S. canal | 485 | m |
| Length of tunnel and power house | 315 | m |

| | | |
|---|---|---|
| Total length of diversion channel | 1,950 | m |
| Width of U.S. canal at entrance | 250 | m |
| Minimum width of canal bed | 50 | m |
| Width of D.S. canal at power house | 278.5 | m |
| Max. depth of canal excavation | 85 | m |
| Max. design discharge | 11,000 | $m^3$/sec. |

*TUNNELS*

| | | |
|---|---|---|
| Number of main tunnels | 6 | |
| Number of tunnel branches | 12 | |
| Length of tunnel | 282 | m |
| Internal dia. of tunnel | 15 | m |
| Min. thickness of concrete lining | 1 | m |
| Number of intakes for each tunnel | 2 | |
| Number of openings per intake | 2 | |
| Size of gate per opening | 5×20 m | |
| Weight of each gate | 230 | tons |
| Total weight of gates and operating mechanisms | 10,500 | " |

*POWER STATION*

| | | |
|---|---|---|
| Number of units | 12 | |
| Total installed capacity | 2,100,000 | kw. |
| Type of turbines | Francis | |
| Turbine capacity at design head | 180,000 | kw. |
| Design head | 57.5 | m. |
| Head variation | 77-35 | m. |
| Turbine discharge at design head | 346 | $m^3$/sec. |
| Speed | 100 | r.p.m. |
| Diameter of runner | 6.5 | m. |
| Weight of turbine | 765 | t. |
| Capacity of generator | 175,000 | kw. |
| Generating voltage | 15,750 | Volts |
| Weight of generator | 1,600 | t. |
| Annual energy generated | 10,000 | mill. k.w.h. |
| Total weight of generating units and accessories | 28,500 | t. |
| Total weight of gates and their mechanisms | 19,700 | t. |

*TRANSMISSION LINES*

| | | |
|---|---|---|
| Number of main lines to Cairo | 2 | |
| Main transmission voltage | 500 | kv. |
| Total length of main lines | 1,580 | km. |
| Intermediate transmission voltages | 220 & 132 | kv. |
| Total length of intermediate lines | 940 | km. |
| Number of 500 kv/220 & 132 kv transformer stations | 3 | |
| Distribution voltages | 66 & 33 | kv. |
| Number of 220/33 & 132/33 transformer stations | 12 | |


Alexandria I
Alexandria II
Damanhour
Mahalla Kobra
Port Said
Tanta
El Tahrir
Zagazig
Ismailia
Cairo North
القاهرة
Cairo
Cairo North East
Cairo South
Suez
Banisuef
Samalut
El Minya
Mallawi
Asyut
Sohag
Nag Hamadi
Quseir
مشروع السد العالى
خطوط القوى الكهربائية
ضغط ٥٠٠، ٢٢٠، ١٣٢ كيلوفولت
HIGH DAM
Transmission Lines of
500,220,132.K.V
Isna
Idfu
Kom_Ombo
Kima
محطة كهرباء خزان اسوان
Aswan Power St.
السد العالى
Sadd_El_Aali
POWER STATION